MODULE-3

Work Study

BVCOENM - Vision & Mission

INSTITUTE

VISION: **"Social transformation through dynamic education"**

MISSION: **To impart quality education to meet the needs of industry, profession and society; and to achieve excellence in teaching, learning and research.**

DEPARTMENT

VISION: **"To be recognized as leading mechanical engineering discipline by enhancing the knowledge and skills for the sustainable development."**

MISSION:

Sociotechnological Skills: **To educate students through various activities including technical education, research and social service.**

Centre of Focus: **To promote prevailing challenges based projects and activities for socio-economic development.**

Competitiveness: **To develop competency in graduates for their career development to sustain in challenging environment.**

Course Outcome

1. Illustrate the need for optimization of resources and its significance
2. Develop ability in integrating knowledge of design along with other aspects of value addition in the conceptualization and manufacturing stage of various products.
3. Demonstrate the concept of value analysis and its relevance.
4. ***Manage and implement different concepts involved in method study and understanding of work content in different situations.***
5. Describe different aspects of work system design and facilities design pertinent to manufacturing industries.
6. Illustrate concepts of Agile manufacturing, Lean manufacturing and Flexible manufacturing

Content

1. Method study
    1. Micro-motion study
    2. Principles of motion economy
2. Work measurement:
    1. Time study
    2. Work sampling
    3. Standard data
    4. PMTS
    5. MOST

Introduction

Work:-

- "The effort or activity of an individual that is undertaken for the purpose of providing goods or services of value to others and that is considered by the individual to be work"(Hall,194)
- The meaning of work differs from person to person and culture to culture

Organizing work

- It refers how to arrange matters so that people can work in concert to get the work done, division of work between people and groups, the work done by managers at different levels, and coordinating the work of people and groups to make possible to realize the goal of the organization

Introduction

- The term ‘work improvement’ is very wide and includes the study of work and simplification and standardization of methods, equipment and working condition. It is otherwise known as ‘method study’ or method engineering’. Work improvement may be defined as scientific techniques of studying and analyzing the conditions influencing the quantity and quality of work done by the workers
- Work improvement not only improves work efficiency, but also improves human comfort and satisfaction. This is also known as ‘human engineering’ or ‘ERGONOMICS’
- The origin of work study is as old as the existence of the human beings. Perhaps the basic objective of the human beings is to get the work done in better or easier way and this is the core concept of work study.

Work Study

- F. W. Taylor - Scientific Management Frederick Winslow Taylor (1856-1915) is considered as the father of Modern Industrial Engineering and he did much pioneering Work in the field of work study.
- His effort and ideas in 'Scientific Management and work Measurement' in Industrial Engineering came into existence in USA in 188 1.
- He concentrated his activities in the area of maximum production in minimum time and developed a formula. It has three elements :
- (a) A definite task : The best and correct sequence of operation
- (b) A definite time : By stopwatch or from standard data
- (c) A definite method : Developed by a detailed experimentation.
- Taylor developed and proved the technique of management called as the task system. He tried to eliminate the brutalization of men, started in Industrial Revolution. Due to scientific management and technical advances a new impersonal relation came about between employers and workmen.

Work Study

- ***Definition-***

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

- ***Role of work-study***

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

Work Study

- Work study is an important tool in the hands of management for achieving greater productivity in the organization.
- It is a methodical study of the use of workers, materials and equipment in order to enhance existing methods and work performance by elimination of every type of waste.

Scope Of Work Study

- Though the work study is originally developed for improving the productivity and efficiency of the production, the technique is applicable widely.
- Industrialists and educationalists have recognized its significance and have been applying in every field even in transport offices, sales and distribution and many more service organizations.
- Work study finds a place in every field for improvement of the method.
- Further it is useful to any field and at any point of time anywhere for exhibiting the excellence.

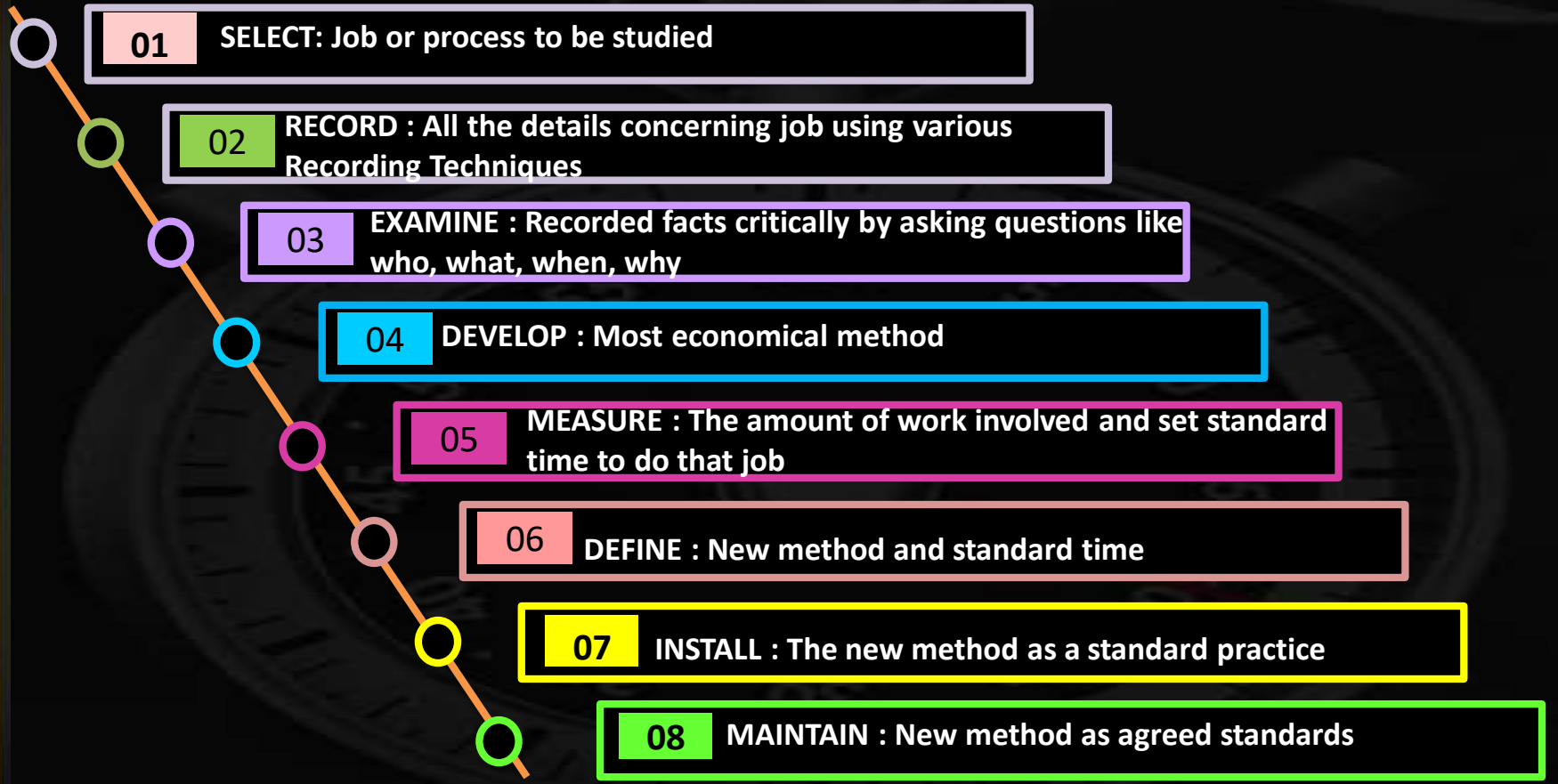
Objectives Of Work Study

a) Improvement in working process.
b) Standardization of procedures.
c) Effective utilization of resources like men, materials, machine, money and time.
d) Efficient and fast material handling.
e) Decision on fair day wage.
f) Enabling a good decision making on manpower requirements, etc.
g) Better work culture, working environment by ergonomic studies.
h) To provide an effective control of system.
i) To make the method of doing operation easy.
j) To economies the movements i.e. motion economy.
k) To increase the productivity by eliminating the unnecessary work elements.
l) To make an effective layout of work place so as to reduce the number of movements.

Advantages Of Work Study

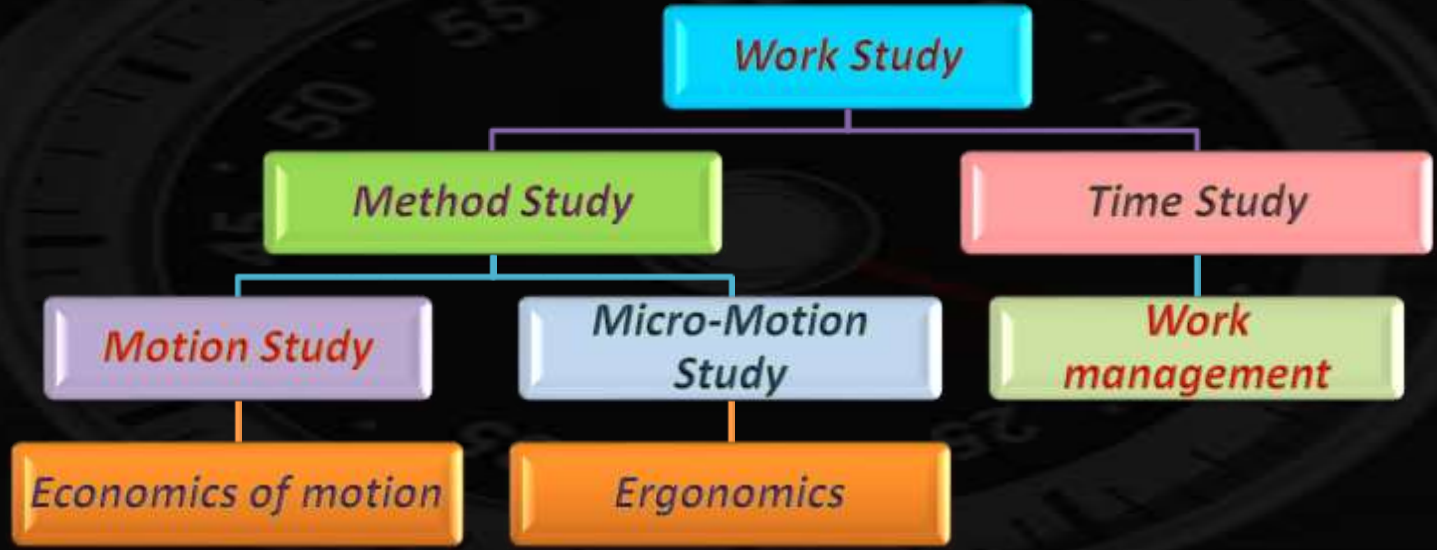
- ✓ Work study ensures higher productivity,
- ✓ Better working conditions with less fatigue,
- ✓ Higher wages to workers,
- ✓ Uniform production flow,
- ✓ Job satisfaction and job security to workers,
- ✓ Reduction in unit cost of production,
- ✓ Quality products to consumers,
- ✓ Fast delivery schedule,
- ✓ Harmonious employer-employee relation, and
- ✓ Better service to customers

Work Study Procedure



Work Study

- Work study is the investigation, by means of consistent system to attain the best possible use of available men, machine, materials, money and time. Total concept of the work study is concentrated upon the answers of following two questions.
  - How should a job be done? How a job should be done? (Method Study)
  - How much time a job should take for completion? (Time Study or Work Measurement)



METHOD STUDY

Method Study

- The systematic recording and critical examination of existing and proposed ways of doing work as a means of developing and applying easier and more effective methods, and reducing costs.
- Method study is a systematic method of analyzing the method of doing a job including human movements involved in it.
- Method study is basically conducted to simplify the work or working methods and must go towards higher productivity.
- It is always desirable to perform the requisite function with desired goal minimum consumption of resources

Method Study

There are three aspects of its application:

- Method study proper is concerned with broad investigation and improvement of a shop/section, the layout of equipment and machines and the movement of men and materials.

1. Motion study is a more detailed investigation of the individual worker/ operator, layout of his machines, tools, jigs and fixtures and movement of his limbs when he performs his job.
2. The ergonomics aspect i.e. study of environment, body postures, noise level and surroundings temperature also form part of investigation.
3. Micro motion study i.e. much more detailed investigation of very rapid movements of the various limbs of the worker.

Method Study

Objective and scope of method study:-

1. The improvement of processes and procedures.
2. Factory and work place layout improvement.
3. Improvement in the design of plant and equipment.
4. Reduction in unnecessary fatigue and movements.
5. Use of improved materials, machines and manpower.
6. Better Working conditions.

Procedure of Method Study

Select	• Work which can be studied with economic advantages
Record	• All facts about the job/person
Examine	• The fact critically seek alternatives , simplifies eliminate, combine or changes
Develop	• A record of an improved methods under prevailing condition reexamine and select best condition
Evaluate	• Evaluate different alternative to developing anew improved method comparing the cost-effectiveness
Define	• Method, procedure, layout, equipment working condition, quality instruction
Install	• The improve method plan arrange and implement
Maintain	• Verify at regular interval that the improved is in use

Method Study

Activity recording and exam aids

- I. The recording techniques are designed to simplify and standardize the recording work. For this purpose charts and diagrams are used.
- II. For recording the movements, the chief techniques used are:
  1. Memo-motion analysis
  2. Micro-motion analysis 3. Flow diagrams.

Charts to record moments in shop

I. However, the most commonly used technique used for recording is by using flow charts.

II. These are classified into three different types:-

1. Outline Process Charts,
2. Flow Process Charts
3. Two Handed Process Chart.

Scope of Method Study

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

Considerations For Selection Of Method Study

Economic Aspect

- Bottleneck operations which are holding up other production operations
- Operations involving excessive labor
- Operations producing lot of scrap or defectives.
- Operations having poor utilization of resources
- Backtracking of materials and excessive movement of materials

Technical Aspect

- Job having in consistent quality. operations generating lot of scraps
- Frequent complaints from workers regarding the job.

Human Aspect

- Workers complaining about unnecessary and tiring work
- More frequency of accidents
- Inconsistent earning.

Advantages & Disadvantages of Method Study

Advantages of method study

- Work simplification
- Improved working method (cheaper method)
- Better product quality
- Improved workplace layout
- Improved equipment design
- Better working conditions

Disadvantages of method study

- High operating cost
- High wastage & scrap
- Excessive movement of materials and workmen
- Excessive production bottlenecks
- Excessive rejections and rework
- Complaints about quality

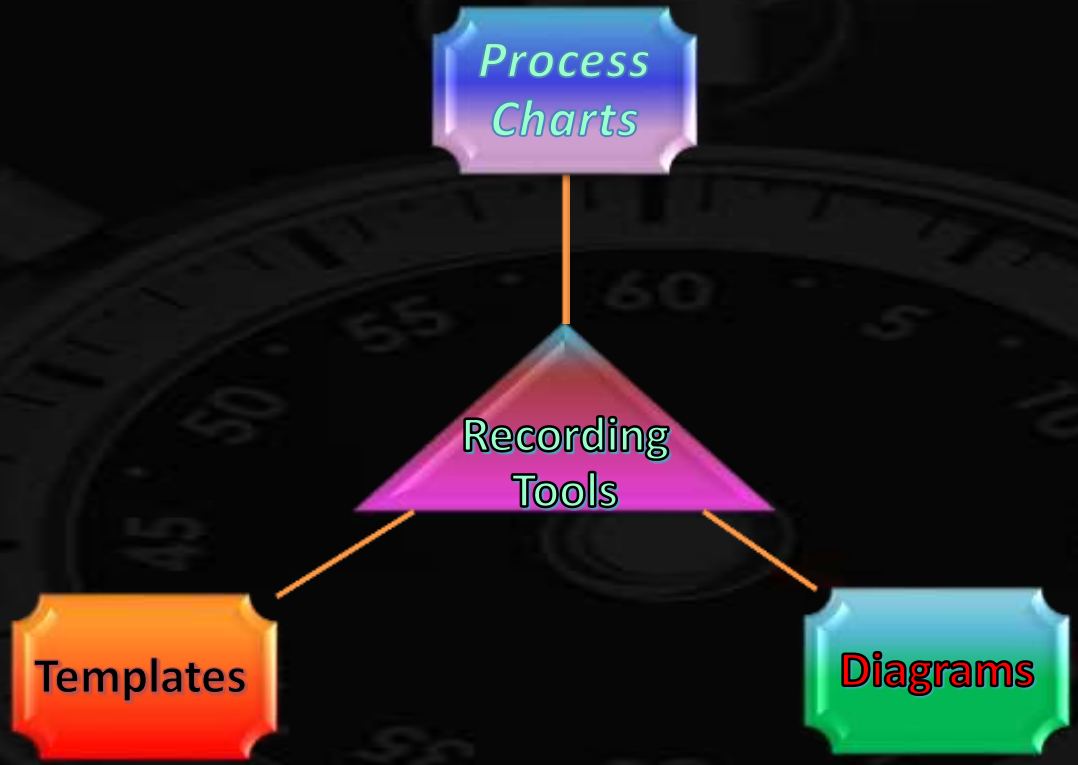
Information Collection Techniques

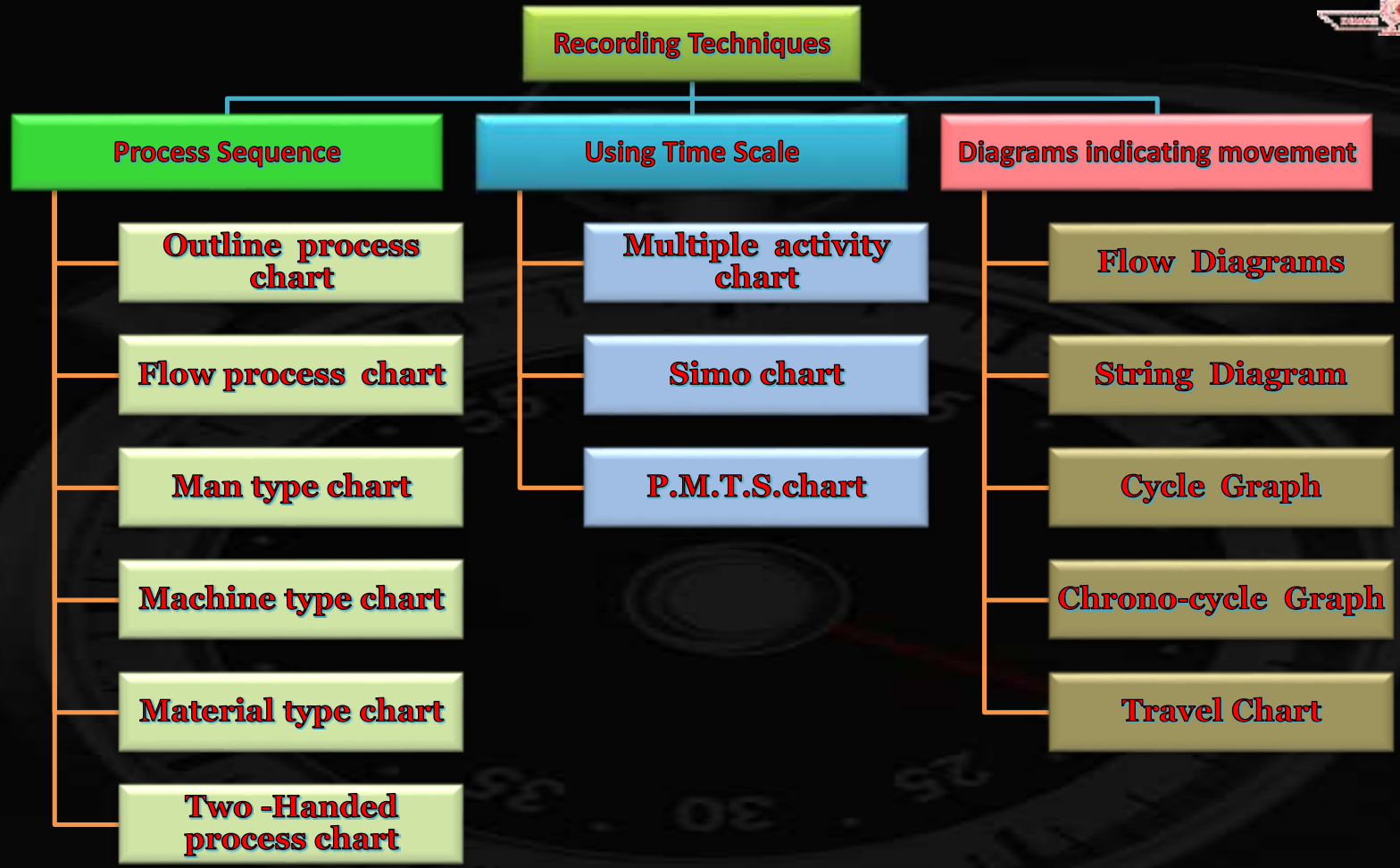
- The accuracy of data about the method study problem is important for the development of improved method.
- The following techniques are used for the collection of information / data about the task under consideration.
- ***Observation-*** It is a common technique used for collecting information about the present method or the existing problem. The method study person visits the site where the work is currently being done and observes various steps in the method being followed. There are many instances where all the data needed is obtained by only observing the work or work site.
- ***Discussion-*** Discussion with those who do or who supervise the work can frequently provide information not obtainable by observation. The discussion technique is commonly used where irregular work is involved or where one is trying to analyze past work in order to improve efficiency of work to be done in future.

Information Collection Techniques

- ***Records-*** Valuable information can be obtained from past records concerning production, cost, time, inventory and sub-contracts. For certain type of information concerning the past practice, sometimes this is the only way to obtain authentic data.
- ***Motion Pictures or video Films-*** Accurate and most detailed information can be obtained by taking motion pictures or video film. Information obtained by this procedure can easily be transmitted / forwarded to all levels in the organization and if needed, can be used directly for training purposes. The film can be used to focus attention at particular point or motion in an operation. For obtaining information concerning those types of work that involve large crew size, it is probably the only procedure.

Information Recording Techniques




Recording Techniques
Process Sequence
Using Time Scale
Diagrams indicating movement
Outline process chart
Flow process chart
Man type chart
Machine type chart
Material type chart
Two -Handed process chart
Multiple activity chart
Simo chart
P.M.T.S.chart
Flow Diagrams
String Diagram
Cycle Graph
Chrono-cycle Graph
Travel Chart

Types of Charts

Operation process charts

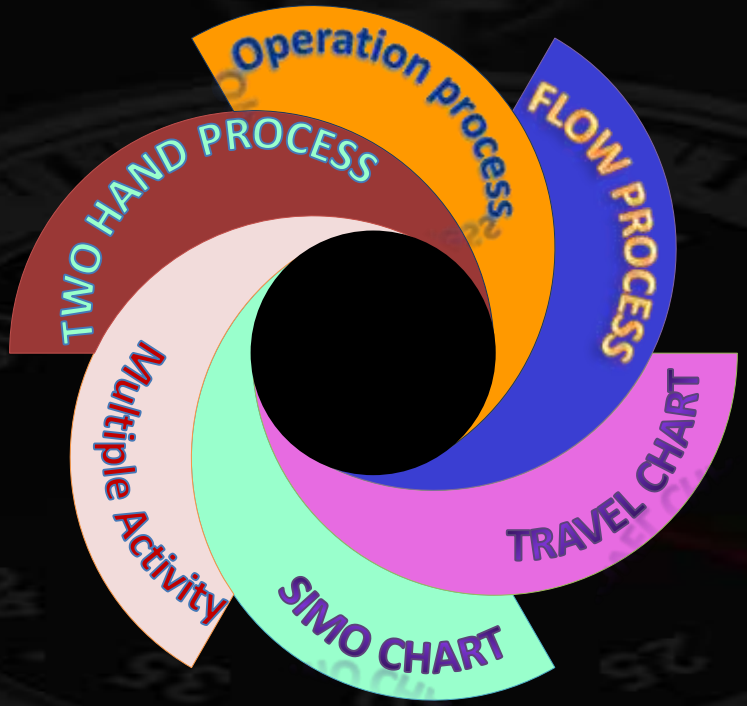
Gives Bird Eye View of Process and records principal operations and inspections

Two handed charts

Activities performed by worker's Two hands

Multiple activity charts

Charts activities of men and/or machines on a common time scale



Flow process charts

Man – Material – Equipment Type : sequence of activities performed by worker, Material, equipment respectively

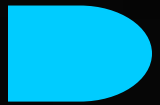
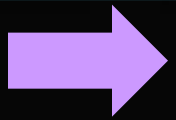
Travel chart

Movements of materials and/or men between departments

SIMO Chart

Activities of worker's hands, legs and other body movements on common time scale

Process Chart Symbol

Events	Symbol	Action	Examples
Operation		Add Value	Saw, Cut, Paint, Packaging
Storage		Warehouse	Warehouse or Storage Location
Delay		Temporary Delay/Hold	WIP Hold, Queue
Transport		Moves Some Distance	Convey, Truck
Inspection		Checks For Defects	Visual Inspect, Dimension Inspect

Operation process charts

Process Chart is a graphic means of representing the activities that occur during a manufacturing or servicing job.

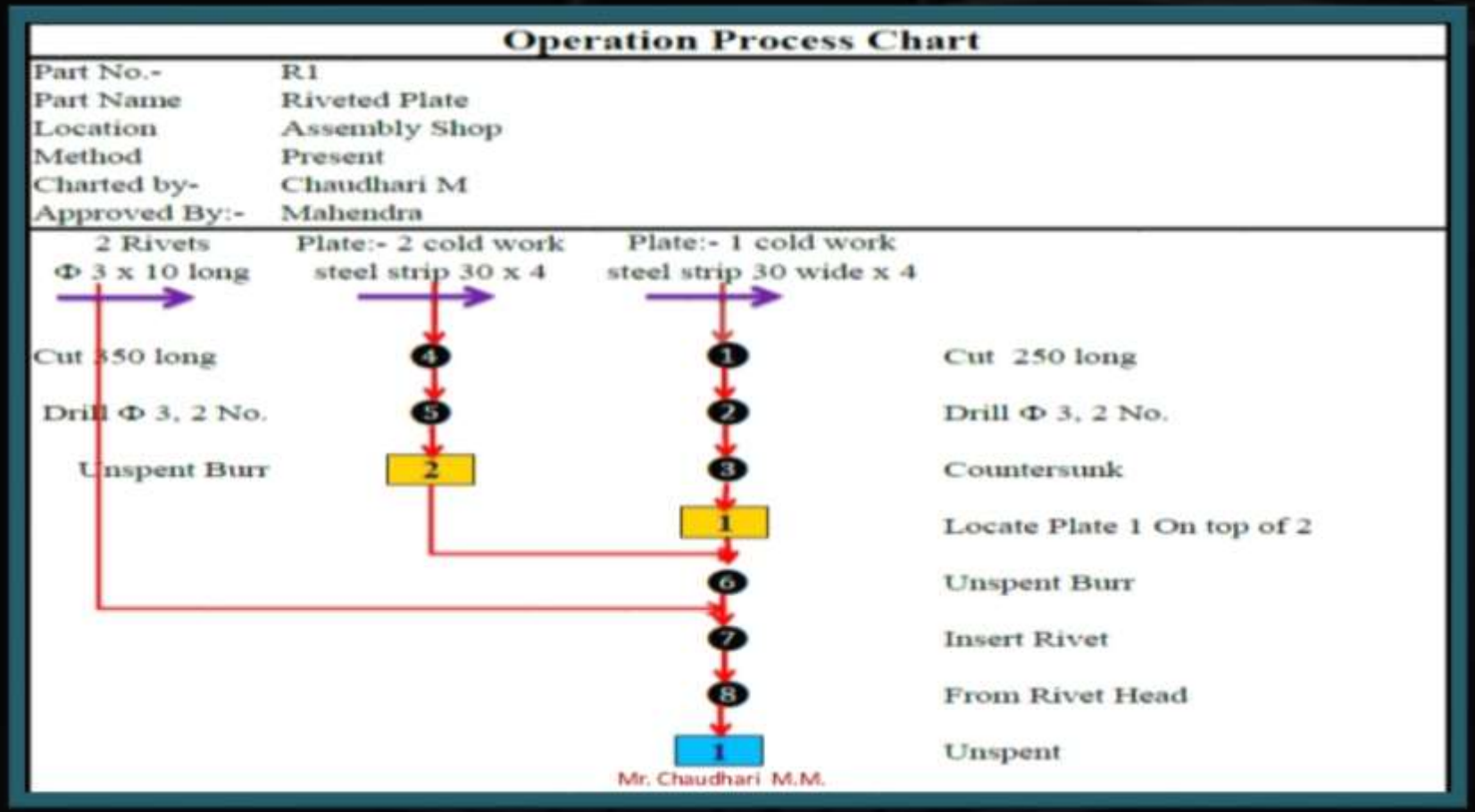
- There are several types of process charts. These can be divided into two groups.

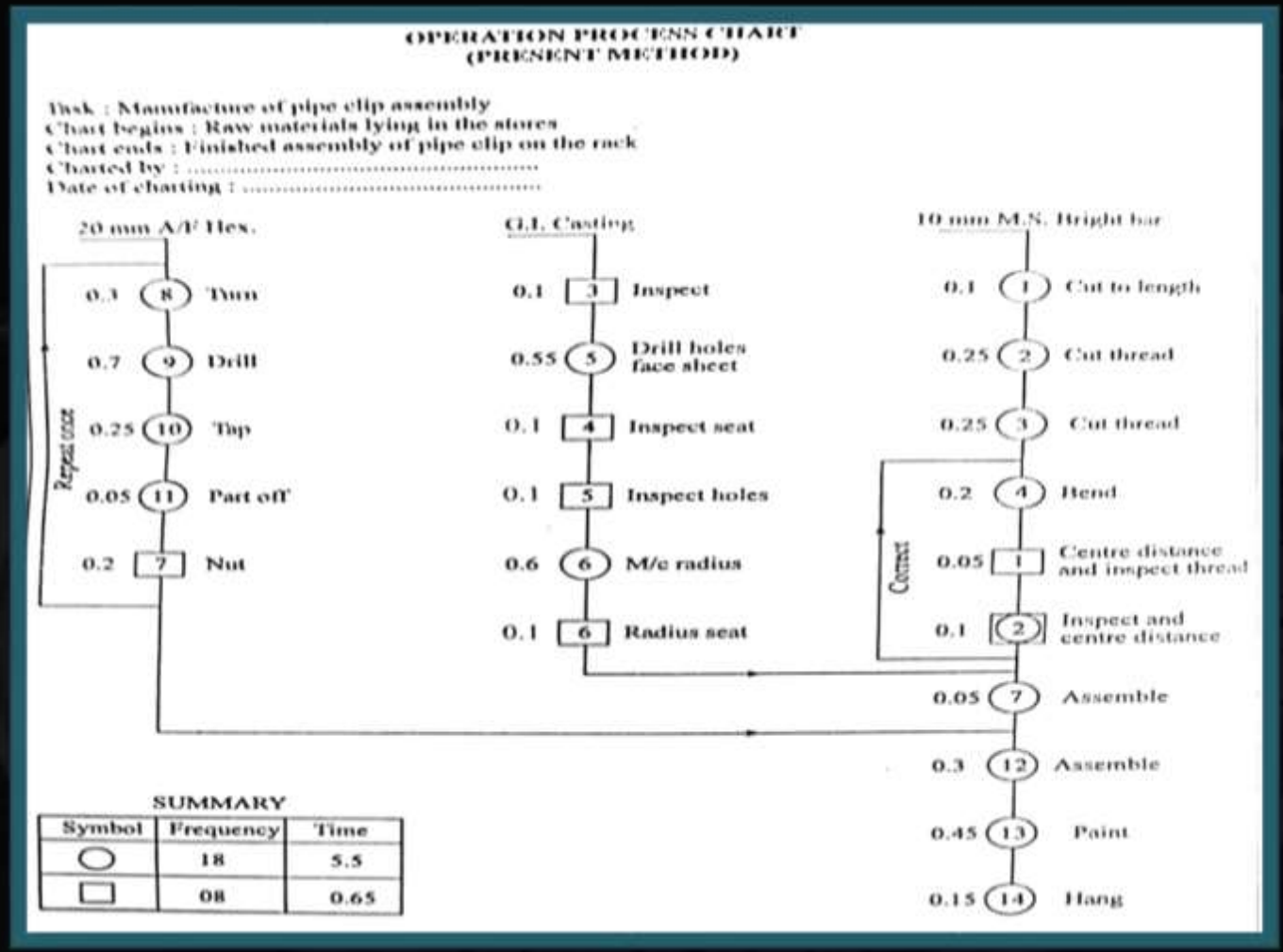
1. Those which are used to record a process sequence (i.e. series of events in the order in which they occur) but do not depict the events to time scale. Charts falling in this group are
   - Operation process chart
   - Flow process chart – (man / material / equipment type)
   - Operator chart (also called Two Handed Process Chart)
2. Those which record events in the sequence in which they occur on a time scale so that the interaction of related events can be more easily studied. Charts falling in this group are
   - Multiple activity chart
   - Simo chart

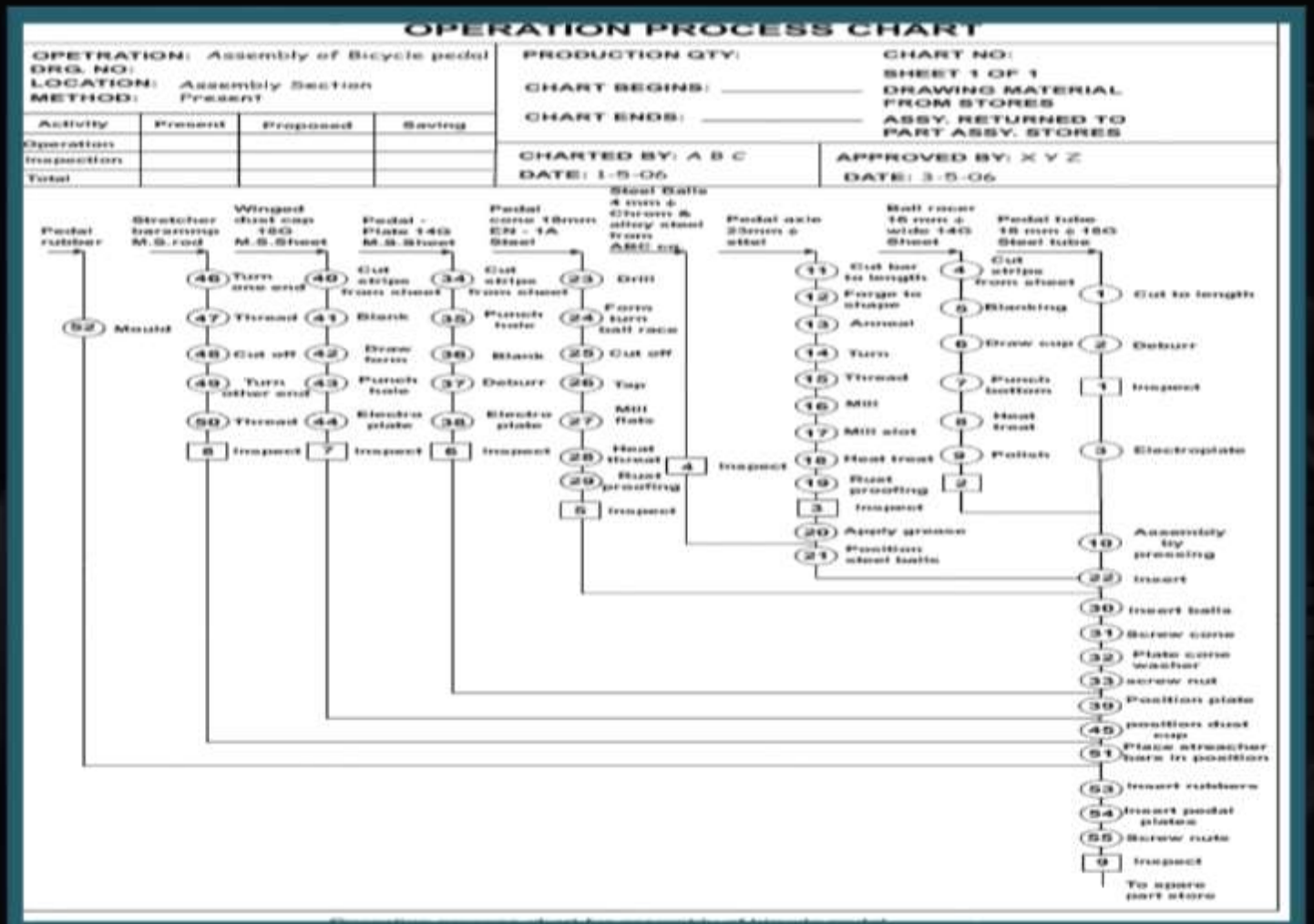
Operation process charts

- *It is also called outline process chart.*
- An operation process chart gives the bird's eye view of the whole process by recording only the major activities and inspections involved in the process.
- Operation process chart uses only two symbols like:-
  I. Operation
  II. Inspection.
- Operation, process chart is helpful to:
  - Visualize the complete sequence of the operations and inspections in the process.
  - Know where the operation selected for detailed study fits into the entire process.
  - In operation process chart, the graphic representation of the points at which materials are introduced into the process and what operations and inspections are carried on them are shown.

Example- Operation Process Chart



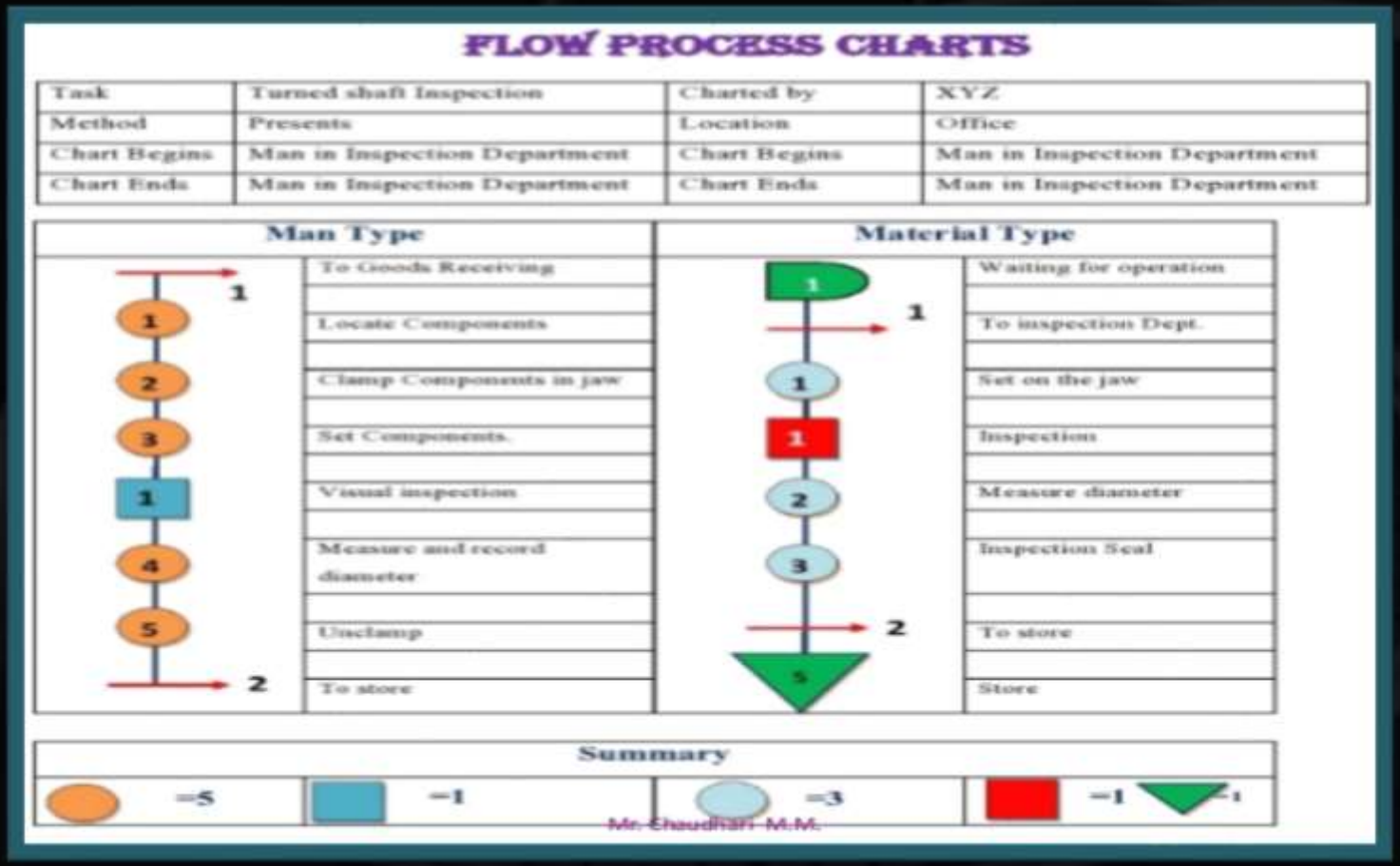

OPERATION PROCESS CHART
(PRESENT METHOD)
Task : Manufacture of pipe clip assembly
Chart begins : Raw materials lying in the stores
Chart ends : Finished assembly of pipe clip on the rack
Charted by : .....
Date of charting : .....
20 mm A/F Hex.
0.3 8 Turn
0.7 9 Drill
0.25 10 Tap
0.05 11 Part off
0.2 7 Nut
Repeat cycle
C.I. Casting
0.1 3 Inspect
0.55 5 Drill holes face sheet
0.1 4 Inspect seat
0.1 5 Inspect holes
0.6 6 M/c radius
0.1 6 Radius seat
10 mm M.S. Bright bar
0.1 1 Cut to length
0.25 2 Cut thread
0.25 3 Cut thread
0.2 4 Bend
0.05 1 Centre distance and inspect thread
0.1 2 Inspect and centre distance
Connect
0.05 7 Assemble
0.3 12 Assemble
0.45 13 Paint
0.15 14 Hang
SUMMARY
Symbol | Frequency | Time
○ | 18 | 5.5
□ | 08 | 0.65


OPERATION PROCESS CHART
OPETRATION: Assembly of Bicycle pedal
DRG. NO:
LOCATION: Assembly Section
METHOD: Present
PRODUCTION QTY:
CHART BEGINS:
CHART ENDS:
CHART NO:
SHEET 1 OF 1
DRAWING MATERIAL FROM STORES
ASSY. RETURNED TO PART ASSY. STORES
Activity
Present
Proposed
Saving
Operation
Inspection
Total
CHARTED BY: A B C
DATE: 1-5-06
APPROVED BY: X Y Z
DATE: 3-5-06
Pedal rubber
Stretcher barammp M.S.rod
Winged dust cap 18G M.S.Sheet
Pedal - Plate 14G M.S.Sheet
Pedal cone 18mm EN - 1A Steel
Steel Balls 4 mm ϕ Chrom & alloy steel from ABC co.
Pedal axle 23mm ϕ steel
Ball racer 16 mm ϕ wide 14G Sheet
Pedal tube 18 mm ϕ 18G Steel tube
Mould
Turn one end
Thread
Cut off
Turn other end
Thread
Inspect
Cut strips from sheet
Blank
Draw form
Punch hole
Electro plate
Inspect
Cut strips from sheet
Punch hole
Blank
Deburr
Electro plate
Inspect
Drill
Form turn ball race
Cut off
Tap
Mill flats
Heat threat
Rust proofing
Inspect
Inspect
Cut bar to length
Forge to shape
Anneal
Turn
Thread
Mill
Mill slot
Heat treat
Rust proofing
Inspect
Apply grease
Position steel balls
Cut strips from sheet
Blanking
Draw cup
Punch bottom
Heat treat
Polish
Cut to length
Deburr
Inspect
Electroplate
Assembly by pressing
Insert
Insert balls
Screw cone
Plate cone washer
screw nut
Position plate
position dust cap
Place streacher bars in position
Insert rubbers
Insert pedal plates
Screw nuts
Inspect
To spare part store

Flow process charts

- Flow process chart gives the sequence of flow of work of a product or any part of it through the work centre or the department recording the events using appropriate symbols.
- It is the amplification of the operation process chart in which operations; inspection, storage, delay and transportation are represented.
- However, process charts are of three types:
  i. Material type— which shows the events that occur to the materials.
  ii. Man type—Activities performed by the man.
  iii. Equipment type— how equipment is used.

Example - Flow process charts



FLOW PROCESS CHARTS

Task	Turned shaft Inspection	Charted by	XYZ
Method	Presents	Location	Office
Chart Begins	Man in Inspection Department	Chart Begins	Man in Inspection Department
Chart Ends	Man in Inspection Department	Chart Ends	Man in Inspection Department

Man Type

1	To Goods Receiving
1	Locate Components
2	Clamp Components in jaw
3	Set Components.
1	Visual inspection
4	Measure and record diameter
5	Unclamp
2	To store

Material Type

1	Waiting for operation
1	To inspection Dept.
1	Set on the jaw
1	Inspection
2	Measure diameter
3	Inspection Seal
2	To store
5	Store

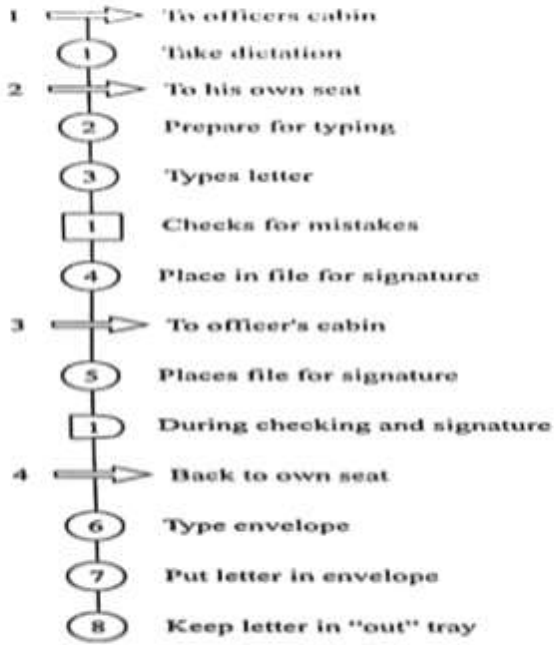
Summary

=5	=1	=3	=1 =1

Mr. Chaudhari M.M.

FLOW PROCESS CHART (Man type)
(PRESENT METHOD)

Task : Writing a letter
Chart begins : Typist in his chiar at his office
Chart ends : Typist puts letter in "out tray"
Charted by : .....
Date of charting : .....

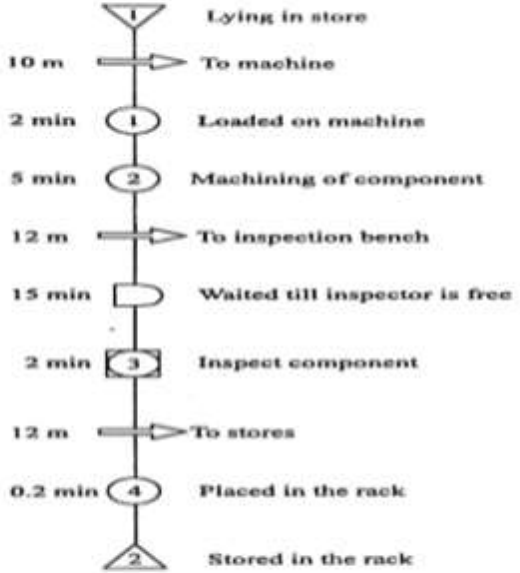


SUMMARY

Symbol	○	⇨	□	▽	D
Frequency	08	04	01	–	01

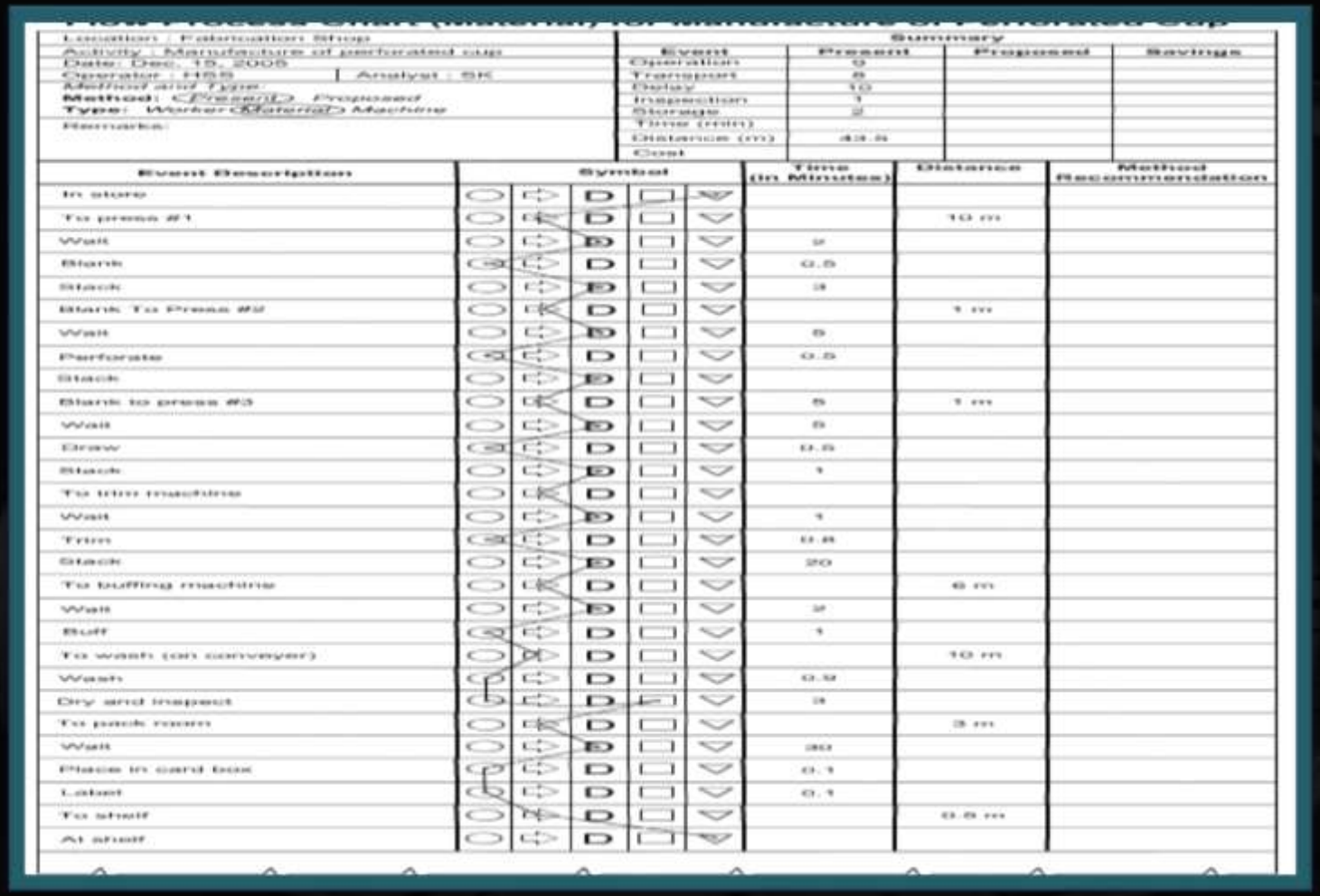
FLOW PROCESS CHART (Material type)
(PRESENT METHOD)

Task : Machining of the component
Chart begins : Component lying in the stores
Chart ends : The machined component lying in the stores
Charted by : .....
Date of charting : .....



SUMMARY

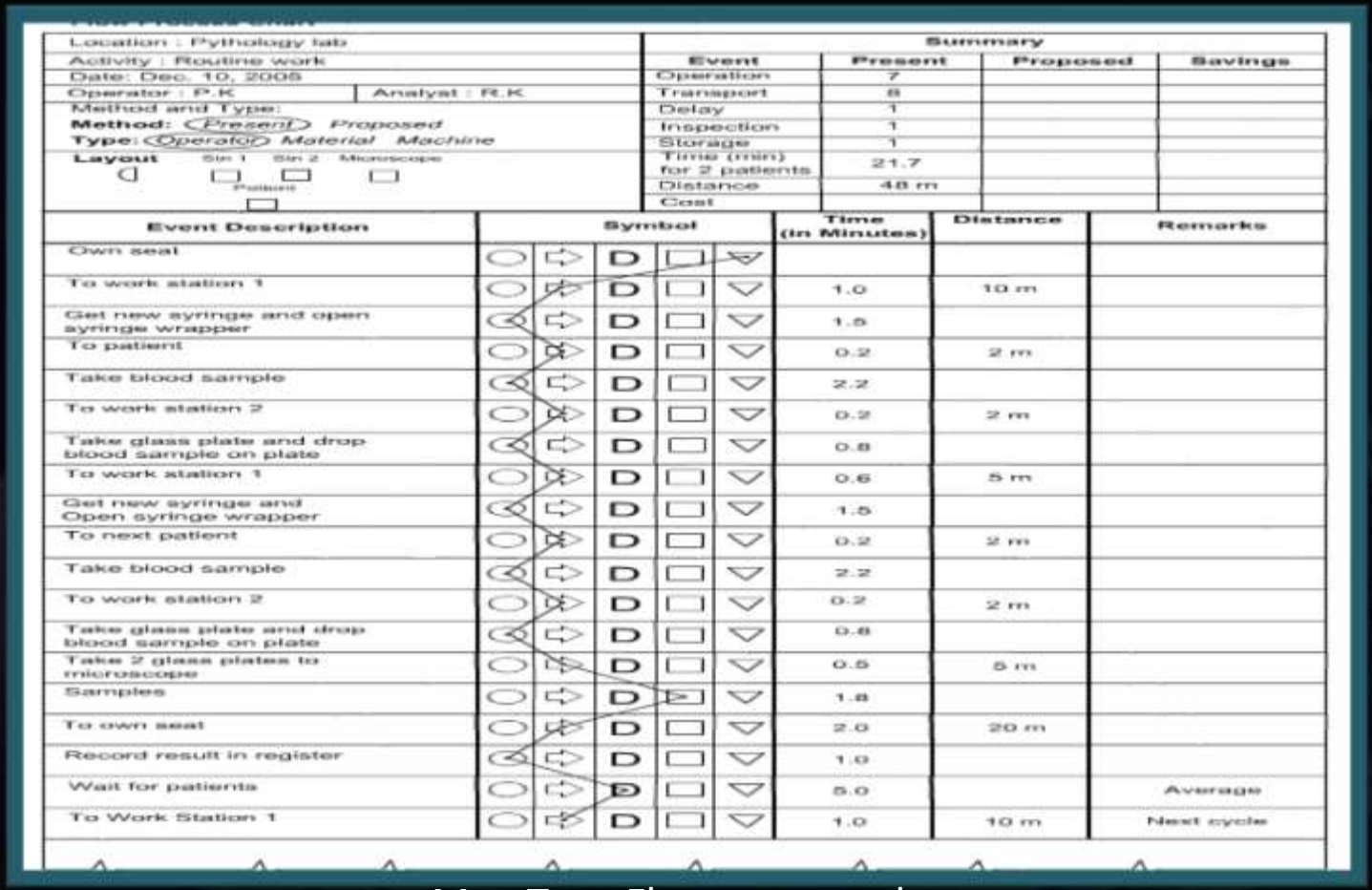
Symbol	Frequency	Time	Distance
○	4	9.2 min	–
⇨	3	–	34 m
□	1	2 min	–
D	1	15 min	–
▽	2	–	–



Location : Fabrication Shop
Activity : Manufacture of perforated cup
Date: Dec. 15, 2005
Operator : HMB | Analyst : SK
Method and Type:
Method: (Present) Proposed
Type: Worker (Material) Machine
Remarks:

Summary			
Event	Present	Proposed	Savings
Operation	9		
Transport	8		
Delay	10		
Inspection	1		
Storage	2		
Time (min)			
Distance (m)	48.5		
Cost			

Event Description	Symbol	Time (in Minutes)	Distance	Method Recommendation
In store	○ ⇨ D □ ▽			
To press #1	○ ⇨ D □ ▽		10 m	
Wait	○ ⇨ D □ ▽	2		
Blank	○ ⇨ D □ ▽	0.5		
Stack	○ ⇨ D □ ▽	3		
Blank To Press #2	○ ⇨ D □ ▽		1 m	
Wait	○ ⇨ D □ ▽	5		
Perforate	○ ⇨ D □ ▽	0.5		
Stack	○ ⇨ D □ ▽			
Blank to press #3	○ ⇨ D □ ▽	5	1 m	
Wait	○ ⇨ D □ ▽	5		
Draw	○ ⇨ D □ ▽	0.5		
Stack	○ ⇨ D □ ▽	1		
To trim machine	○ ⇨ D □ ▽			
Wait	○ ⇨ D □ ▽	1		
Trim	○ ⇨ D □ ▽	0.8		
Stack	○ ⇨ D □ ▽	20		
To buffing machine	○ ⇨ D □ ▽		6 m	
Wait	○ ⇨ D □ ▽	2		
Buff	○ ⇨ D □ ▽	1		
To wash (on conveyer)	○ ⇨ D □ ▽		10 m	
Wash	○ ⇨ D □ ▽	0.5		
Dry and inspect	○ ⇨ D □ ▽	3		
To pack room	○ ⇨ D □ ▽		3 m	
Wait	○ ⇨ D □ ▽	20		
Place in card box	○ ⇨ D □ ▽	0.1		
Label	○ ⇨ D □ ▽	0.1		
To shelf	○ ⇨ D □ ▽		0.5 m	
At shelf	○ ⇨ D □ ▽			



Location : Pythology lab
Activity : Routine work
Date: Dec. 10, 2005
Operator : P.K | Analyst : R.K
Method and Type:
Method: (Present) Proposed
Type: (Operator) Material Machine
Layout Stn 1 Stn 2 Microscope Podium

Summary

Event	Present	Proposed	Savings
Operation	7		
Transport	8		
Delay	1		
Inspection	1		
Storage	1		
Time (min) for 2 patients	21.7		
Distance	48 m		
Cost			

Event Description	Symbol	Time (in Minutes)	Distance	Remarks
Own seat				
To work station 1		1.0	10 m	
Get new syringe and open syringe wrapper		1.5		
To patient		0.2	2 m	
Take blood sample		2.2		
To work station 2		0.2	2 m	
Take glass plate and drop blood sample on plate		0.8		
To work station 1		0.6	5 m	
Get new syringe and Open syringe wrapper		1.5		
To next patient		0.2	2 m	
Take blood sample		2.2		
To work station 2		0.2	2 m	
Take glass plate and drop blood sample on plate		0.8		
Take 2 glass plates to microscope		0.5	5 m	
Samples		1.8		
To own seat		2.0	20 m	
Record result in register		1.0		
Wait for patients		5.0		Average
To Work Station 1		1.0	10 m	Next cycle

Man Type Flow process chart

Travel chart

- It is also known as From-To Chart
- This chart is helpful in analyzing the overall material flow
- It indicates the distance and number of moves between different pairs of departments taken as origin and destination
- The travel chart is helpful in the process type layout design
- It indicates the relationship between different departments in terms of material interaction.
- Attempts should be made in layout design to put those departments close to each other which have high level of material interaction so as to minimize the materials handling requirements provided other objectives are also satisfied

Travel chart

- The chart which gives an estimate about the amount of materials handling between various workstations is known as “Travel Chart”.
- The aim in the construction of Travel Chart is to decide such a layout where overall materials handling function is performed at a minimum cost.

Use of Travel Chart:

- 1) To analyze material handling, and plan department locations.
- 2) To compare layouts and to determine their efficiency.
- 3) To plan materials handling procedure and routes.
- 4) To shorten manufacturing cycles.
- 5) To reduce work in process.
- 6) To reduce labour costs.
- 7) To assist in improving materials handling procedure.
- 8) To determine relative self-sufficiency of various areas.
- 9) To determine inventory control difficulties.
- 10) To make economical use of available areas

Advantages of Travel chart

I. It helps in analyzing the material movement
II. It aids in determining activity locations
III. It alternates flow patterns and layouts can be compared
IV. It shows relationship of different activities in terms of volume of movement
V. It depicts quantitative relationships which can be used for computerized analysis and OR applications.

Two hand activity charts

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

Example- Two hand activity charts

Two - Handed Process - Chart (Present Method)
Job – Assembly of Nuts and Bolts
Chart begins – Both hands free before assembly
Charted ends – Both hands free after assembly
Charted by – Vivek Mishra
Date of charting – 06 oct. 2005

LEFT HAND		RIGHT HAND	
Description	Symbol	Symbol	Description
Reach for bolt	1	1	Reach for nut
Grasp bolt head	1	1	Grasp nut
Carry to central Position	2	2	Carry to central position
Hold Nut	1	2	Place nut on bolt
Transfer Assembly to right - hand	2	3	Screw nut
	1	4	Grasp assembly
Return hand to central position	3	3	Carry to box
		5	Release assembly
		4	Return hand to central position

Summary

Symbol	○	→	▽	D
Frequency (RH)	5	4	–	–
Frequency (LH)	2	3	1	1

TWO HANDED PROCESS CHART
(PRESENT METHOD)

Task : Assembly of nut and bolt
Chart begins : Both hands free before assembly
Chart ends : Both hands free after assembly
Charted by : .....
Date of charting : .....

LEFT HAND		RIGHT HAND	
Description	*Symbol*	*Symbol*	*Description*
Reach for bolt	1	1	Reach for nut
Grasp bolt head	1	1	Grasp nut
Carry to central position	2	2	Carry to central position
Hold bolt		2	Place nut on bolt
		3	Screw nut
Hold bolt		4	Grasp assembly
Transfer assembly to right hand	2	3	Carry to box
		4	Release assembly
		4	Return hand to central position

SUMMARY

Symbol	○	⇨	▽	▷
Frequency (R.H.)	5	4	–	–
Frequency (L.H.)	2	2	2	2

Operator Process Chart

Chart No:	Sht. No:
Org. No:	Part No:
Operation : Assembly of Electrical Tester	
Location : Assembly Section	
Date: 10.02.05	Method: Present
Operator : OPSharma	Analyst : KDSingh

Workplace Layout:

Summary

	Present		Proposed		Savings	
	L.H	R.H	L.H	R.H	L.H	R.H
Operation	2	9				
Transport	3	8				
Hold	1	0				
Delay	0	2				
Time (min)	.50					

Part Sketch of Jig etc

Left Hand Description	○	⇨	○	D	○	⇨	○	D	Right Hand Description
To barrel in bin 1									To filament in bin 5
Pick up barrel									Pick up
To work position									To barrel
Hold									Assemble in barrel
									To resistor in bin 4
									Pick up
									To barrel
									Assemble in barrel
									To clip in bin 3
									Pick up
									To barrel
									Assemble on barrel
									To cap in bin 2
									Pick up
									To barrel
									Position on clip
Hold									Screw in the barrel
To bin 6									Rest on table
Release									Rest on table

Operator process chart for assembly of an electric tester

Critical Examination Sheet

Description of Element: **Reference:**

The Present Facts		Alternatives	Selected Alternative for Development
Purpose - What is achieved ?	Is it necessary ? Yes/No If yes - Why ?	What else could be done ?	What?
Means - How is it done ?	Why that way ?	How else could it be done ?	How ?
Place - Where is it done ?	Why there ?	Where else could it be done ?	When ?
Sequence - When is it done ?	Why then ?	When else could it be done ?	When ?
Person - Who does it ?	Why that person ?	Who else could do it ?	Who ?

Multiple activity chart

- It is a chart where activities of more than subject (worker or equipment) are each recorded on a common time scale to show their inter-relationship.
- Multiple activity chart is made:
  - to study idle time of the man and machines,
  - to determine number of machines handled by one operator, and
  - to determine number of operators required in teamwork to perform the given job.

Multiple activity chart

Multiple Activity Chart
Present Method

Job:-	Machining of Components
Chart Start:-	Loading Part lying Near machine
Chart end	Unloading Part
Charted By:-	Chaudhari M
Charted Date:-	31/12/2019

	Operator			Machine		
Cummulative Time	Operator Description	Time	Symbol	Machine Description	Time	Symbol
0.3	Load Job	0.3		Idle	—	
0.37	Switch ON	0.07		Idle	—	
0.44	Switch ON	0.07		Idle	—	
1.94	Idle	—		Machining of Part	1.5	
2.00	Pickup Job	0.06		Idle	—	
2.05	Keep in Box	0.05		Idle	—	

Subject	Cycle Time	Time work/Cycle	Percentage utilization
Operator	2.05	0.55	26.8
Machine	2.05	1.5	73.2

Idle Machining

MULTIPLE ACTIVITY CHART
(Present Method)

Task : Machining of a component
Chart begins : The part to be machined lying near machine
Chart ends : Machined part lying in the container
Charted by : .....
Charting date : .....

	Operator			*Machine*		
0	Description	T	S		T	S
0.20	LOAD JOB	0.2		IDLE		
0.28	SWITCH 'ON'	0.08		IDLE		
0.36	SWITCH 'ON'	0.08		IDLE		
1.86	IDLE			MACHINING OF PART "Autocycle"	1.5	
1.91	PICKUP PART	0.05		IDLE		
1.96	KEEP IN TRAY	0.05		IDLE		

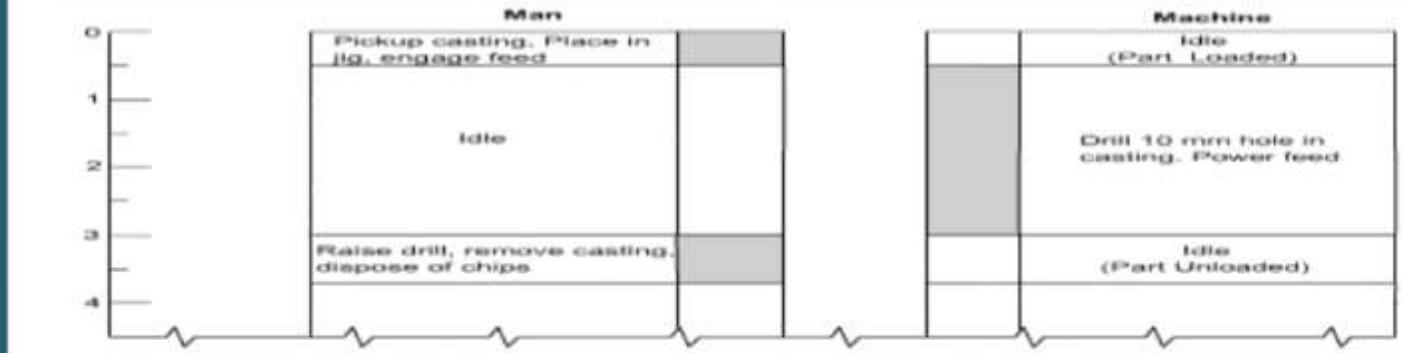
Subject	*Cycle time (min)*	*Time worked per cycle*	*Percentage utilisation*
OPERATOR	1.96	0.46	23.4
MACHINE	1.96	1.5	76.6

Worker - Machine Process Chart

Operator Name : Ram Dyal Sharma
Department : Machine Shop
Activity : Drill hole in casting
Drg.No : C25
Method : Present

Summary

	Man	Machine
Idle time	2.50 minutes	1.25 minutes
Working time	1.25	2.50
Total cycle time	3.75	3.75
Utilization	Operator utilization = $\frac{1.25}{3.75}$ = 33%	Machine utilization = $\frac{2.50}{3.75}$ = 67%

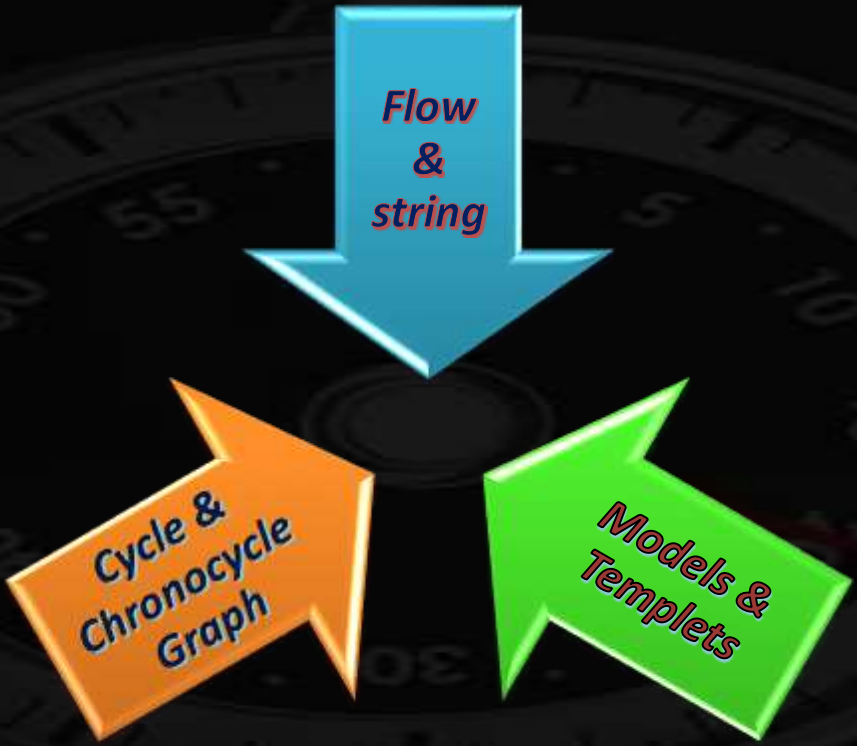


Diagrams

- A diagram gives pictorial view of the layout of workplace or floor on which locations of different equipment, machines, etc. are indicated.
- The movement of subject (man or material) is then indicated on the diagram by a line or a string.
- The diagrams are valuable in highlighting the movement so that analyst can take steps to simplify or reduce it and thus effect saving in time or reduction in collisions / accidents.

Types of Diagram & Templets

Path of movement of men and material



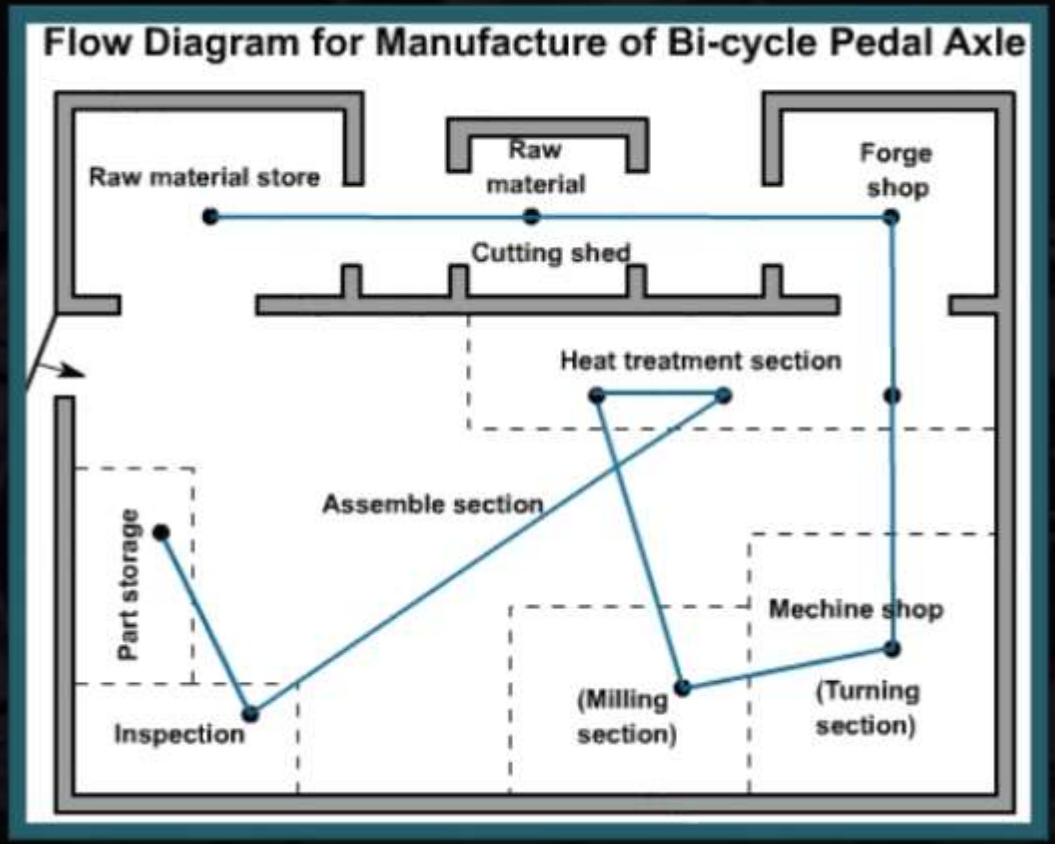
High speed, short cycle operation recording

Work place layout

String Diagram

- ✓ When the paths are many and repetitive, a flow diagram becomes congested, and it is neither easy to trace it nor to understand.
- ✓ Under such condition string diagram is preferred.
- ✓ String diagram is one of the useful and simplest techniques of method study.
- ✓ It can be defined as a scale model on which a thread is used to trace the path or movements of man and materials during a specified sequence of events.
- ✓ String diagram is a scale plan of the shop, in which every machine or work bench is marked, and a peg is struck in the area representing a facility.

Example- String Diagram



Templates and 3-D models

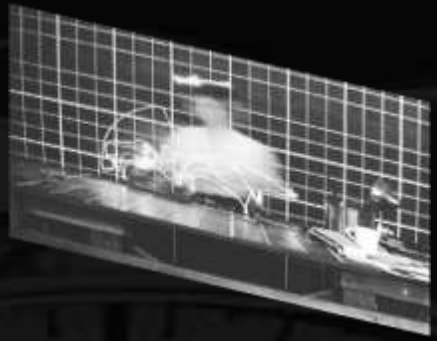
Templates

- Two-dimensional cut outs made from thin card sheet representing machinery, furniture, etc. can be used for developing new layouts and methods.
- The templates may have pieces of permanent magnet attached to them, so that when used on iron board; they remain glued on the board whenever placed.

3-D models

- A scaled 3-D model of a working area helps easy understanding of lighting, ventilation, maintenance and safety aspects that may be important in a method.
- Such models are often of great value in demonstrating the advantages of the proposed changes to all concerned.
- Their use is limited because of higher cost involved.
- Some computer softwares are available which help in constructing the layout and possibility of visualizing the working of process in a systematic way.

Micro-motion Study



Micro-motion Study

- Micro-motion study is a set of techniques indented to divide the human activities in a groups of movement or Micro-motions (called as Therbligs) and the study of such movements helps to find for an operator, one best pattern of movement that consumes less time and requires less effort to accomplish the task.
- "Micro motion study is the technique of recording and analyzing the timing of basic elements of an operation with the objective of achieving the best method of performing the operation."
- Micro motion study is used for graphical presentation of many repetitive operations of short cycle like component assembly, packaging, inspection, separation of mixed jobs, which involve quick movements of hand.
- In certain types of operation like pick and place objects, detailed study of suck operations can be carried out.
- Micro motion study technique is best suited for those operations or activities which are of short duration and which are repeated hundreds of times.

Micro-motion Study

Micro-motion study involves the following steps:

1. Filming the operation to study:- It consists of taking motion pictures of the activity while being performed by an operator. The equipment required to make film or video tape of the operation consists of 16mm movie camera, 16mm film, wink counter (micro-chronometer) and other usual photographic aids. Micro-chronometer is a timing device placed in the field of view while filming . Time is recorded in wink (1 wink= 1/2000 of minute)
2. Analysis of the data from the films:- Once the operation has been filmed and film is processed, then the film is viewed with the help of projector for analysis of micro-motions. Steps:
    1. Film is run at normal speed so as to get familiar with the pattern of movement involved
    2. Typical work cycle is selected from among the filmed cycles
    3. Film is run at a very slow speed and is usually stopped or reversed frequently to identify the motions (Therbligs). These Therbligs are entered in the analysis sheet.
3. Recording of the data (using SIMO chart)

SIMO chart

- “SIMO” stands for simultaneous-Motion Cycle chart.
- It is one of micro motion study devised by Gilbreth and it presents graphically the separable steps of each pertinent limb of the operator under study.
- A SIMO chart is a chart based on the film analysis.
- It is an extremely detailed left- and right-hand operation chart.
- It records simultaneously the different Therbligs performed by different parts of the body of one more operator on a common time scale.
- The movements are recorded against time measured in “Winks” (1 wink= 1/2000 minute).
- These are recorded by a “Wink Counter” positioned in such a location that it can be seen rotating during filming process.

Example- SIMO chart

SIMO Chart						
Operation:-	Assemble Gel Pen			Film No:-1		
Operation No.	1			Operator:-	Chaudhari M.	
Method:-	Present			Date:- 01/01/2020		
Time:-	In sec			Charted By:-		
LH	**Symbol**	**Time**	**Total Time**	**Time**	**Symbol**	**RH**
To Cap	**TE**	12	12	12	**TE**	To Barrel
Grasp Cap	**G**	10	22	10	**G**	Grasp Barrel
Move to Assembly	**TL**	10	32	10	**TL**	Move to Assembly
Hold Cap	**H**	08	42	10	**H**	Hold Cap

Motion Study Sheet

Part: ..... Department: ..... Film No: E.T.102.
Operation: Assembly... Operation No.: ..... Sheet No. .....
Operator: ..... Analyzed by: Gurunath..... Checked by: Bapu

Left Hand Details	Therblig	Time(Sec.)	Time(Sec)	Therblig	Right Hand Details
1. To grasp	G	7 secs	6 sec	G	1. To grasp
2. To unload.	RL	10 secs	11 sec.	TE	2. To lift
3. To transport	TL	10 sec.	5 sec	RL	3. To unload
4. To press	P	6 sec.	7 sec.	P	4. To load.
5. To hold gun	H	5 sec.	6 sec	H	5. To hold
6. To weld.	U	40 sec.	31 secs.	U	6. To weld.
7. To press	P	5 sec	4 secs.	G	7. To grasp
8. To grasp	G	6 sec	6 secs.	TL	8. To unload.
9. To transport	TL	11 sec.			

(a)

Motion Study Sheet

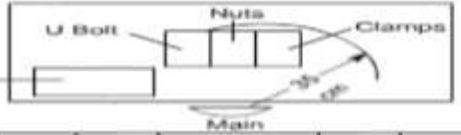
Part: ..... Department: ..... Film No: E.T.102.
Operation: Assembly. Operation No.: ..... Sheet No. .....
Operator: ..... RH..... Analyzed by: Gurunath. Checked by: Bapu

Left Hand Details	Therblig	Time(Sec.)	Time(Sec)	Therblig	Right Hand Details
1. To grasp	G	5 secs	6 secs	G	1. To grasp
2. To unload.	TL	9 secs	8 secs	TL	2. To unload.
3. To search	SH	6 secs	6 secs.	G	3. To grasp
4. To grasp	G	5 secs	11 secs	TE	4. To load.
5. To load.	TE	9 secs	45 secs	U	5. To weld.
6. To hold gun	H	4 secs	8 secs	RL	6. To unload.
7. To weld.	U	41 secs			
8. To unload	RL	8 secs			

(b)

Operation: Assemble Clamps and Bolt	Part: CC-5	Summary	Left Hand	Right Hand
Operator Name and No.: P.B.#120		Effective Time:	3.3	11.4
Analyst: P.Kumar	Date:08/08/05	Ineffective Time:	10.2	2.1
Method: (Present) Proposed		Cycle Time =	13.50 sec.	

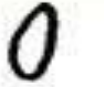
Sketch of workplace:



Left hand Description	Symbol	Time Sec		Time Sec	Symbol	Right Hand Description
Get U Bolt	REG	1.00		1.00	REG	Get Clamp
Place U Bolt	MP RL	1.20		1.20	MP RL	Place Clamp
				1.00	REG	Get Nut #1
				1.20	MP	Place Nut #1
				3.00	U RL	Run Down Nut #1
Hold U Bolt	H	10.20				
				1.00	REG	Get Nut #2
				1.20	MP	Place Nut #2
				3.00	U RL	Run Down Nut #2
Dispose off Assembly	M RL	1.10		0.90	UD	Wait

Therbligs

- The system of symbols that represent every elementary of hand / arm and eye movements.
- The term Therbligs is an anagram of "Gilbreth" and was coined by Frank and Lillian Gilbreth for their system of studying, timing and analyzing the motions of workers.
- Therbligs are usually aimed at manual tasks and are often used in the field of time and motion studies.
- Therbligs are ***18 kinds of elemental motions***, used in the study of motion economy in the workplace.

Therblig	Colour	Symbol/Icon	Therblig	Colour	Symbol/Icon
Search	Black		Use	Purple	
Find	Gray		Disassemble	Violet, Light	
Select	Light Gray		Inspect	Burnt Orange	
Grasp	Lake Red		Pre-Position	Sky Blue	
*Hold	Gold Ochre		Release Load	Carmine Red	
Transport Loaded	Green		Unavoidable Delay	Yellow Ochre	
Transport Empty	Olive Green		Avoidable Delay	Lemon Yellow	
Position	Blue		Plan	Brown	
Assemble	Violet, Heavy		Rest for overcoming fatigue	Orange	

Therbligs

Effective Therbligs

(Directly advance progress of work. Can be shortened but difficult to eliminate completely.)

Therblig	Symbol		Description	Example
Reach		RE	Motion of empty hand to or from object; time depends on distance moved; usually preceded by Release and followed by Grasp.	Moving empty hand to grasp a screw on the table.
Move		M	Movement of loaded hand; time depends on distance, weight, and type of move; usually preceded by Grasp and followed by Release or Position.	Carrying a screw driver to the screw head.
Grasp		G	Closing fingers around an object; begins as the fingers contact the object and ends when control has been gained; time depends on type of grasp; usually preceded by Reach and followed by Move.	Closing fingers around a screw lying on the table.
Release		RL	Relinquishing control of object, typically the shortest of the therbligs.	Letting go of a component in a tray.
Pre-Position		PP	Positioning Object in predetermined location for later use; usually occurs in conjunction with Move, as in orienting a wrench for tightening a bolt.	Placing a tapered shank drill in a hole in rack.
Use		U	Manipulating device or tool for intended use; begins when hand starts to work with tool or device, and ends when the hand finishes the application.	Using a spray gun to spray an object.
Assemble		A	Bringing two mating parts together; usually preceded by position or Move; followed by Release.	Fitting friction cap on the pen.
Disassemble		DA	Separaing mating parts; usually preceded by Grasp and followed by Move or Release.	Removing tool from tool post.

Ineffective Therbligs

(Do not advance progress of work. Should be eliminated if possible.)

Therblig	Symbol		Description	Example
Search		S	Eyes or hands hunting for object; begins as the eyes move in to locate an object.	Searching a 5 mm drill from a box containing assorted drills.
Select		SE	Choosing one item from several; usually preceded by Search.	A 5 mm drill is located in a box containing assorted drills.
Position		P	Turning or orienting object during work, usually preceded by Move and followed by Release.	Positioning screw driver to bring its tip into slot of screw head.
Inspect		I	Comparing object with standard, generally with sight, but could also be with the other senses.	Visually checking the presence of any scratch on enambled surface.
Plan		PL	Mental reaction; pausing to determine next action; ususally detected as a hesitation preceding motion.	In making an assembly, an operator decides which parts should be assembled first.
Unavoidable Delay		UD	Beyond the operator's control due to the nature of the operation, usually occurs when left hand is waiting while right hand completes its work.	Using right hand to feed rotaing drill into workpiece while the left hand waits.
Avoidable Delay		D	Operator solely responsible for the delay.	An operator rotates the lathe chuck by hand before switching on the spindle motor.
Rest to overcome Fatigue		R	Relaxation period; appears periodically, not every cycle, depends on the physical workload.	An operator pauses during hand forging or hand filing operation.
Hold		H	One hand supports object while other does useful work.	Holding bolt in one hand while assembling a washer onto it by the other hand.

Cycle graph

- These are the techniques of analyzing the paths of motion made by an operator and were originally developed by the Gilbreths.
- To make a cycle graph , a small electric bulb is attached to the finger, hand, or any other part of the body whose motion is to be recorded.
- By using still photography, the path of light of bulb (in other words, that of the body member) as it moves through space for one complete cycle is photographed.
- The working area is kept relatively less illuminated while photograph is being taken.
- More than one camera may be used in different planes to get more details.
- After the film is developed, the resulting picture (cycle graph) shows a permanent record of the motion pattern employed in the form of a closed loop of white continuous line with the working area in the background.

Cycle graph

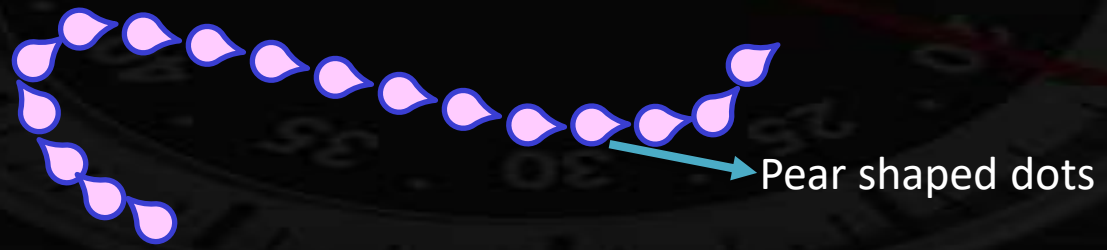
- A photograph showing movement depicted as a continuous pattern of light.
- A cycle graph does not indicate the direction or speed of motion.
- The technique was ***first used in 1890 by Marley*** to study the movements of athletes and later developed by Gilbreth in the study of work.
- It can be used for
  - Improving the motion pattern, and
  - Training purposes in that two cycle graphs may be shown with one indicating a better motion pattern than the other.

Chronocycle Graph

- ✓ The chrono cycle graph is similar to the cycle graph, but the power supply to the bulb is interrupted regularly by using an electric circuit.
- ✓ The bulb is thus made to flash.
- ✓ The procedure for taking photograph remains the same.
- ✓ The resulting picture (chrono cycle graph), instead of showing continuous line of motion pattern, shows short dashes of line spaced in proportion to the speed of the body member photographed.
- ✓ Wide spacing would represent fast moves while close spacing would represent slow moves.
- ✓ The jumbling of dots at one point would indicate fumbling or hesitation of the body member.
- ✓ The path of light appears as a series of pear-shaped dots, the movement being in the direction in which the dots point.
- ✓ The spacing between the dots indicate the speed of movement and show acceleration and deceleration.

Chronocycle Graph

- ✓ A chrono cycle graph can thus be used to study the motion pattern as well as to compute velocity, acceleration and retardation experienced by the body member at different locations.
- ✓ The world of sports has extensively used this analysis tool, updated to video, for the purpose of training in the development of form and skill.



Principles Of Motion Economy

- These principles can be considered under three different groups
  1. Those related to the use of the human body.
  2. Those related to the workplace arrangement, and
  3. Those related to the design of tools and equipment

1. Principles related to the use of human body:

1. The two hands should begin as well as complete their motions at the same time.
2. The two hands should not be idle at the same time except during rest period.
3. Motions of the arms should be made in opposite and symmetrical directions and should be made simultaneously.
4. Hand and body motions should be confined to the lowest classification with which it is possible to perform the work satisfactorily.

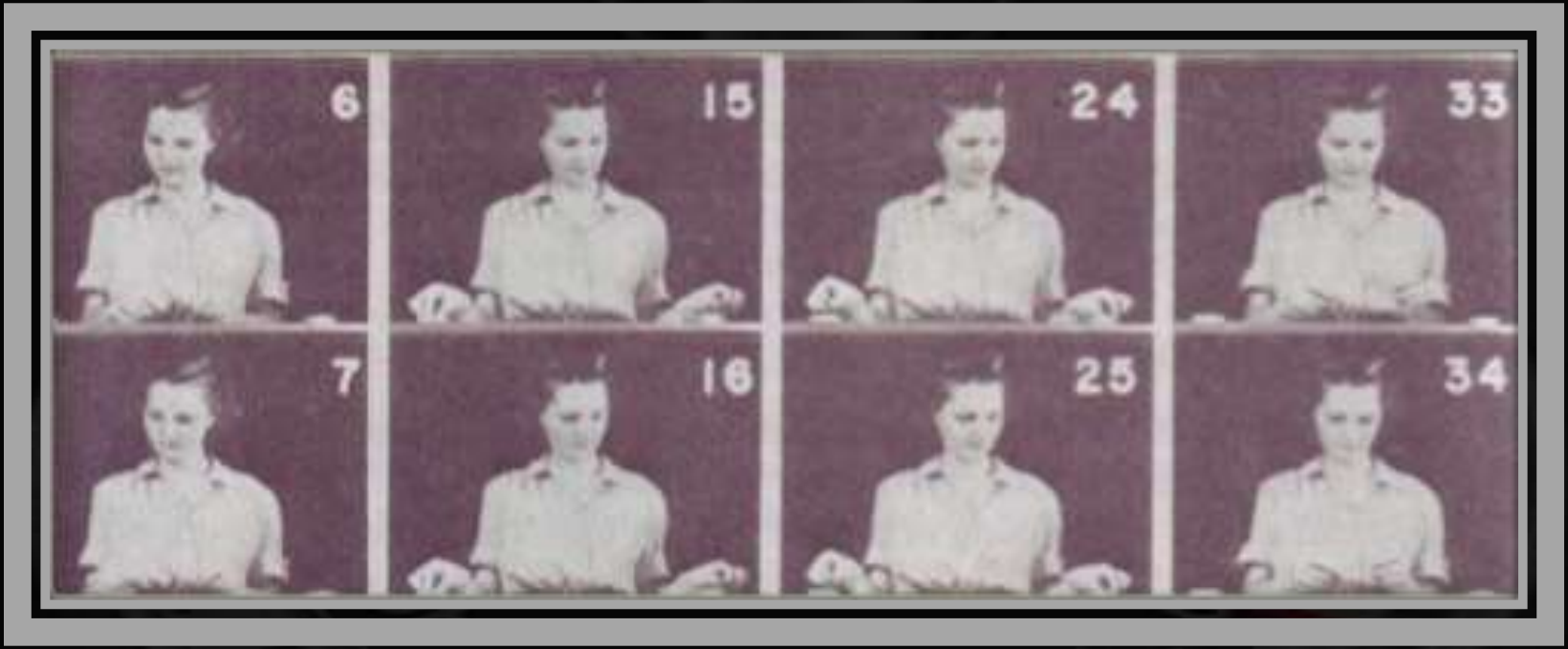
   General Classification of Hand Motions

   a. Finger motions.
   b. Motions involving fingers and wrist.
   c. Motions involving fingers, wrist, and forearm.
   d. Motions involving fingers, wrist, forearm, and upper arm.
   e. Motions involving fingers, wrist, forearm, upper arm and shoulder.

1. Principles related to the use of human body:

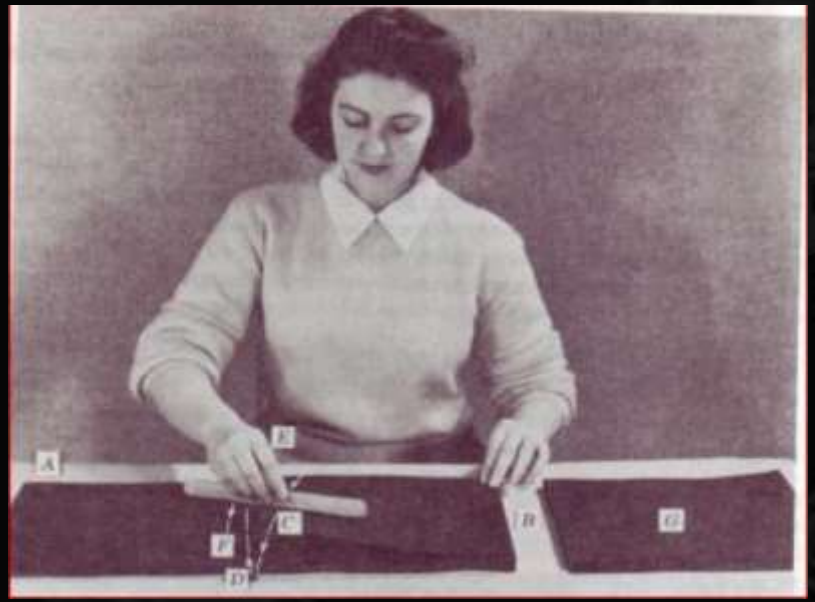
5. Momentum should be employed to assist the worker wherever possible, and it should be reduced to a minimum if it must be overcome by muscular effort.
6. Smooth continuous curved motions of the hands are preferable to straight line motion involving sudden and sharp changes in direction.
7. Ballistic movements are faster, easier, and more accurate than restricted (fixation) or "controlled" movements.
8. Work should be arranged to permit an easy and natural rhythm wherever possible.
9. Eye fixations should be as few as close together as possible.
   - Eye Movements
   - Eye – Hand Coordination

Example on use of human body using motion picture film



Print of motion picture film showing eye and hand motions of the operator assembling small parts.

Principles of motion economy on use of human body - example



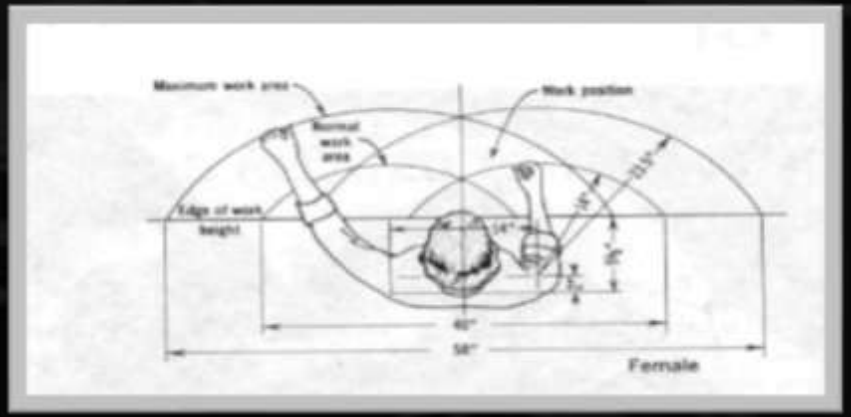
Path of hand in creased folded sheet of paper (Old method). There is an abrupt change in direction D and also E. Two strokes of bone are used to crease the fold.

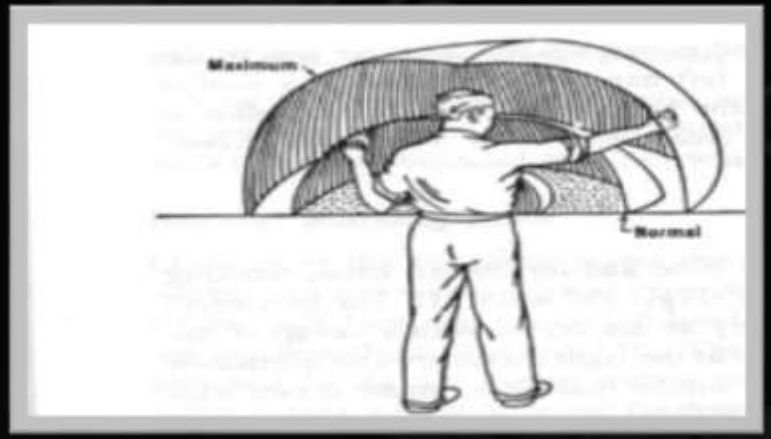
Path of hand in creased folded sheet of paper (improved method). The hand makes a smooth S curve creasing the fold with one stroke of bone. Output is increased by 43%

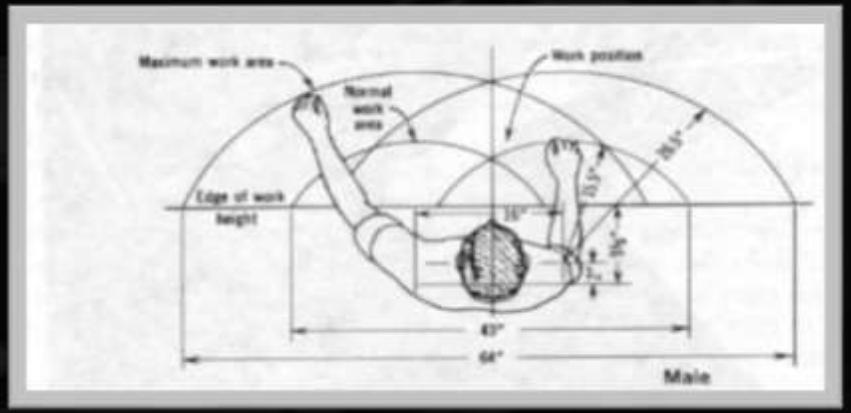
2. Principles related to the arrangement and conditions of workplace:

10. There should be a definite and fixed place for all tools and materials.
11. Tools, materials, and controls should be located close to the point of use.
    - Normal working area
    - Maximum working area
12. Gravity fed, bins and container should be used to deliver the materials as close to the point of use as possible.
13. All materials and tools should be located within the normal working area in both the vertical and horizontal plane , and as close to the point of use as possible.
14. Materials and tools should be arranged to permit the best sequence of motions.
15. 'Drop deliveries' or ejectors should be used wherever possible, so that the operator does not have to use his/her hands to dispose of finished parts.
16. Work table height should permit work by the operator in alternately sitting and standing posture and Glare-free adequate illumination, proper ventilation and proper temperature should be provided.

Principles of motion economy related to arrangement of workplace



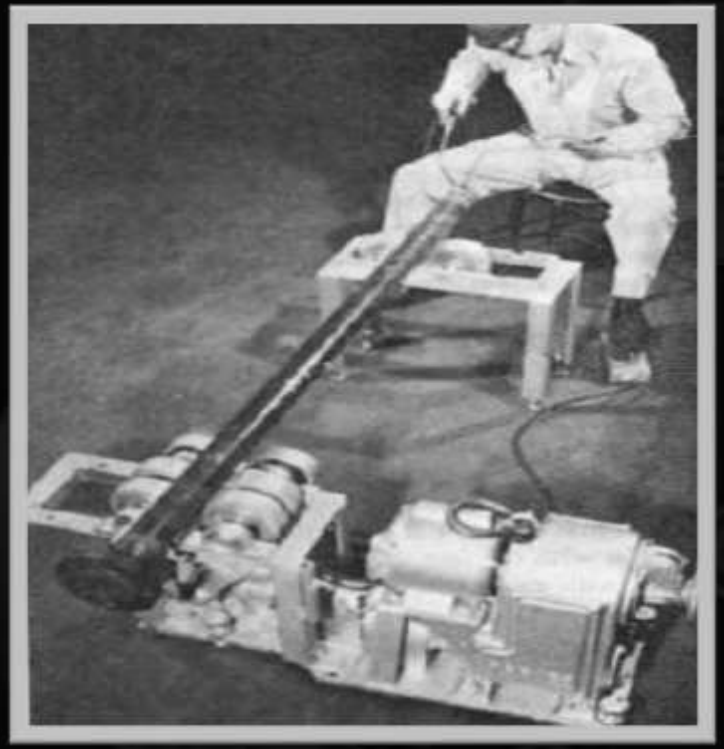




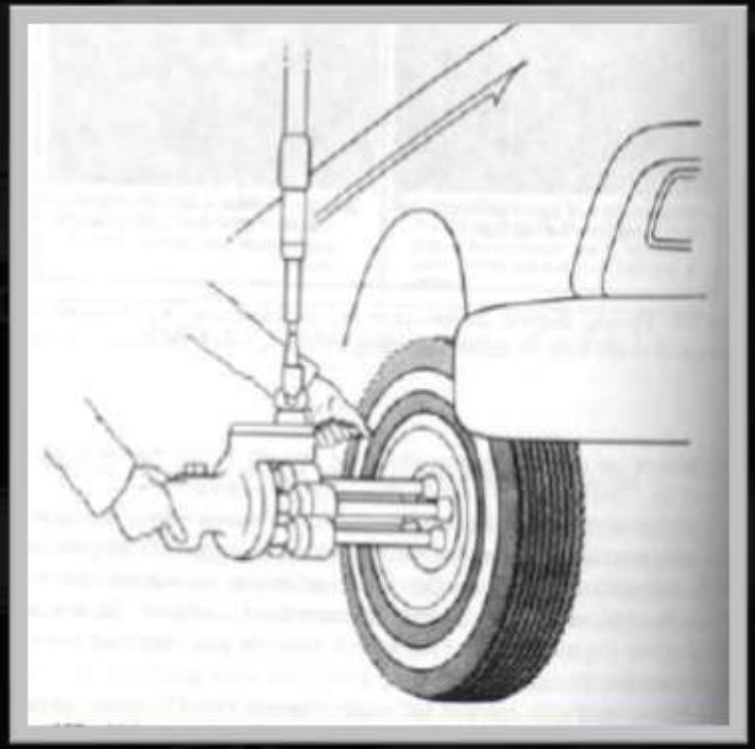
3. Principles related to the design of tools and equipment:

17. The color of the workplace should contrast with that of the work and thus reduce eye fatigue.
18. The hands should be relieved from ‘holding’ the work piece where this can be done by a jig, fixture or foot-operated device.
19. Two or more tools should be combined wherever possible
20. Where each finger performs some specific movement, as in typewriting, the load should be distributed in accordance with the inherent capacities of the fingers
21. Handles such as those on cranks and large screwdrivers should be designed so as to permit as much of the surface of the hand as possible to come into contact with the handle. This is especially necessary when considerable force has to be used on the handle
22. Levers, crossbars and hand-wheels should be placed so that the operator can use them with the least change in body position and the greatest mechanical advantage

Principle of motion economy related to design of equipment - example



Foot controlled motor driven unit rotates pipe for welder



Multi-spindle air-operated nut runner can tighten all wheel nuts at once

Work Measurement

Work Measurement

- Work measurement refers to the estimation of standard time for an activity, that is the time allowed for completing one piece of job by using the prescribed method.
- Standard time can be defined as the time taken by an average experienced worker for the job with provisions for delays beyond the worker's control.
- Work measurement deals with assessing the time content of a job performed by an operator to determine the proper time to be allowed and the efforts required for the efficient performance of a job
- R.M. Curie has defined work measurement as ‘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 popularly known as ‘time study’ which is a major constituent of the work study.

Objectives Of Work Measurement

1. COMPARING ALTERNATIVE METHODS
2. ASSESSING THE CORRECT INITIAL MANNING (MANPOWER REQUIREMENT PLANNING)
3. PLANNING AND CONTROL
4. REALISTIC COSTING
5. DELIVERY DATE OF PLANNING
6. COST REDUCTION AND COST CONTROL
7. IDENTIFYING SUBSTANDARD WORKERS
8. TRAINING NEW EMPLOYEES

Work Measurement

Its advantages are as follows:

- Work measurement determines the normal time for a job and thereby serves as a basis of a sound wage incentive system.
- The standard time determined by work measurement helps in labor cost control.
- Work measurement provides the relevant data for efficient work planning and control.
- Work measurement facilitates effective manning of plant and equipment.
- Work measurement technique can be useful in reducing the time and cost involved in the proposed production orders.

Techniques Of Work Measurement

1. ***REPETITIVE WORK:-*** The type of work in which the main operation or group of operations repeat continuously during the time spent at the job these apply to work cycle of extremely short duration
2. ***NON-REPETITIVE WORK:-*** It include some type of maintenance and construction work, where cycle itself is hardly ever repeated identically

VARIOUS TECHNIQUES:-

1)TIME STUDY
2) SYNTHESIS
3) WORK SAMPLING
4)PREDETERMINED MOTION AND TIME STUDY (PMTS)

Time Study

Definition:

- Time study is a technique to estimate the time to be allowed to a qualified and well-trained worker working at a normal pace to complete a specified task by using specified method.
- This technique is based on measuring the work content of the task when performed by the prescribed method, with the allowance for fatigue and for personal and unavoidable delays.
- Time study is work measurement technique for recording the times and rates of working for the elements of a specified job carried out under specified under specified conditions

Time Study Procedure

1. Define objective of the study. This involves statement of the use of the result, the precision desired, and the required level of confidence in the estimated time standards.
2. Verify that the standard method and conditions exist for the operation and the operator is properly trained. If need is felt for method study or further training of operator, the same may be completed before starting the time study.
3. Select operator to be studied if there are more than one operator doing the same task.
4. Record information about the standard method, operation, operator, product, equipment, and conditions on the Time Study observation sheet.
5. Divide the operation into reasonably small elements and record them on the Time Study observation sheet.

Time Study Procedure

6. Time the operator for each of the elements. Record the data for a few numbers of cycles on the Time Study observation sheet. Use the data to estimate the total number of observations to be taken.
7. Collect and record the data of required number of cycles by timing and rating the operator.
8. Calculate the representative watch time for each element of operation. Multiply it by the rating factor to get normal time.
   - ✓ Normal time = Observed time x Rating factor
   - ✓ Calculate the normal time for the whole operation by adding the normal time of its various elements.
9. Determine allowances for fatigue and various delays.
10. Determine standard time of operation.
    - – Standard time = Normal time + allowances

Time Study

Selection of job for Time Study

- Time Study is conducted on a job
  - which has not been previously time-studied.
  - for which method change has taken place recently.
  - for which worker(s) might have complained as having tight time standards.

Selection of Worker for Time Study

- The selection of worker for time study is a very important factor in the success of the study. If there is only one person on the job, as usually is, then there is no choice. But if more than one person is performing the same operation, the time study man may time one or more of the workers. If all the workers are using the same method for doing the job and there is different in the rate of their doing it, it is necessary to select a suitable worker for the study. The worker on which time study should be conducted must
  - have necessary skill for the job.
  - have sufficient experience with the given method on the job (that is, he should have crossed the learning stage).
  - be an ‘average' worker as regards the speed of working.
  - be temperamentally suited to the study (those who can't work in normal fashion when watched, are not suitable for the study).
  - have knowledge about the purpose of study.

Time Study Equipment

The following equipment is needed for time study work.

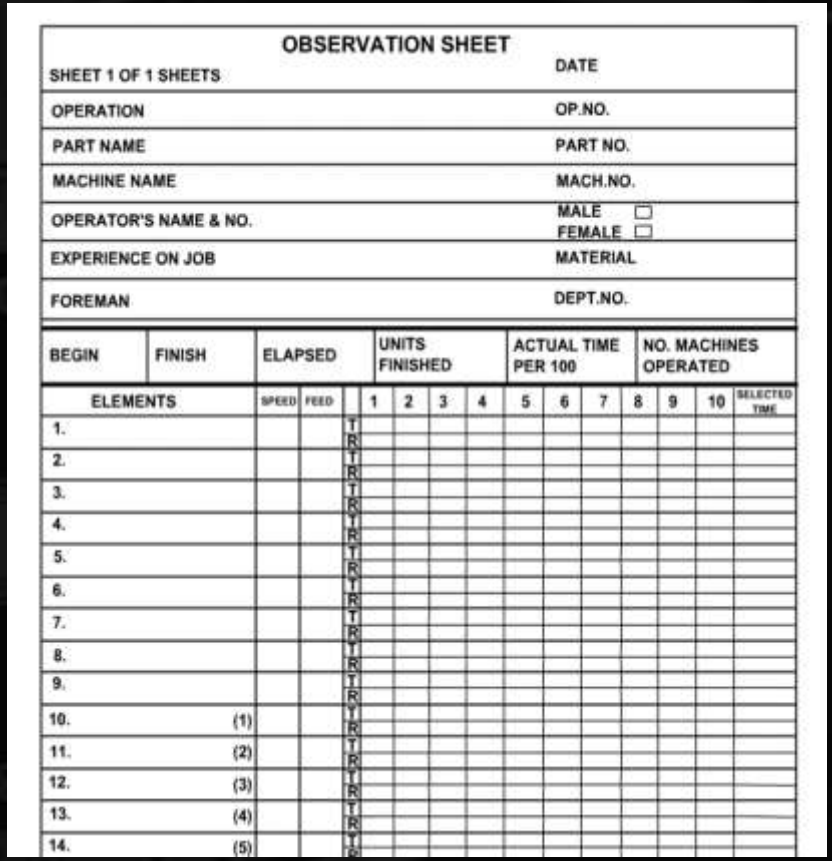
- Timing device
- Time study observation sheet
- Time study observation board
- Other equipment

Timing Device

- The stopwatch is the most widely used timing device used for time study, although electronic timer is also sometimes used.
- The two perform the same function with the difference that electronic timer can measure time to the second or third decimal of a second and can keep a large volume of time data in memory.

Time Study Observation Sheet

- It is a printed form with spaces provided for noting down the necessary information about the operation being studied, like name of operation, drawing number, and name of the worker, name of time study person, and the date and place of study.
- Spaces are provided in the form for writing detailed description of the process (element-wise), recorded time or stop-watch readings for each element of the process, performance rating(s) of operator, and computation.



OBSERVATION SHEET

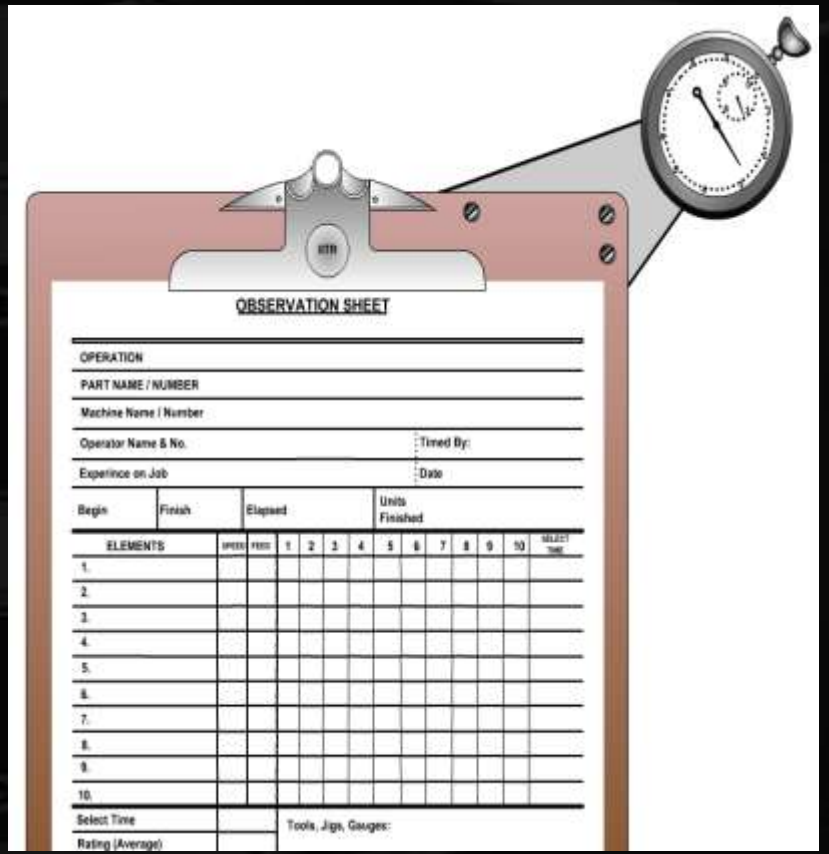
SHEET 1 OF 1 SHEETS	DATE
OPERATION	OP.NO.
PART NAME	PART NO.
MACHINE NAME	MACH.NO.
OPERATOR'S NAME & NO.	MALE ☐ FEMALE ☐
EXPERIENCE ON JOB	MATERIAL
FOREMAN	DEPT.NO.

BEGIN	FINISH	ELAPSED	UNITS FINISHED	ACTUAL TIME PER 100	NO. MACHINES OPERATED

ELEMENTS	SPEED	FEED	T	1	2	3	4	5	6	7	8	9	10	SELECTED TIME
1.			R											
2.			R											
3.			R											
4.			R											
5.			R											
6.			R											
7.			R											
8.			R											
9.			R											
10. (1)			R											
11. (2)			R											
12. (3)			R											
13. (4)			R											
14. (5)			R											

Time Study Board

- It is a light -weight board used for holding the observation sheet and stopwatch in position.
- It is of size slightly larger than that of observation sheet used. Generally, the watch is mounted at the center of the top edge or as shown in Figure near the upper right-hand corner of the board.
- The board has a clamp to hold the observation sheet.
- During the time study, the board is held against the body and the upper left arm by the time study person in such a way that the watch could be operated by the thumb/index finger of the left hand.
- Watch readings are recorded on the observation sheet by the right hand.
- Other Equipment. This includes pencil, eraser, device like tachometer for checking the speed, etc.



Dividing Work into Short Elements

- Timing a complete task as one element is generally not satisfactory.
- For the purpose of time study the task is normally broken into short elements and each element is timed separately, for the following reasons:
  1) To separate unproductive part of task from the productive one.
  2) To improve accuracy in rating. The worker may not work at the same speed throughout the cycle. He may perform some elements faster and some slower. Breaking of task into short elements permits rating of each element separately which is more realistic than just rating once for the complete cycle.
  3) To identify elements causing high fatigue. Breaking of task into short elements permits giving appropriate rest allowances to different elements.
  4) To have detailed job specifications. This helps in detection of any variation in the method that may occur after the time standard is established.
  5) To prepare standard data for repeatedly occurring elements.

Types Of Element

- ***A REPETITIVE ELEMENT*** – Is an element which occurs in every work cycle of the job.
- ***AN OCCASIONAL ELEMENT*** - Does not occur in each work cycle of the job, but which may occur at regular or irregular intervals. E.G. Machine setting.
- ***A CONSTANT ELEMENT*** - The basic time remains constant whenever it is performed. E.G. Switch the machine on.
- ***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. e.g. Push trolley of parts to next shop.

Types Of Element

- ***MANUAL ELEMENT*** - Is an element performed by a worker.
- ***MACHINE ELEMENT*** - Is automatically performed by a power-driven machine (or process).
- ***GOVERNING ELEMENT*** - Occupies a longer time than any of the other elements which are being performed concurrently. E.G. Boil kettle of water, while setting out teapot and cups.
- ***FOREIGN ELEMENT*** - Is observed during a study which, after analysis, is not found to be necessary part of the job. E.G. Degreasing a part that has still to be machined further.

Performance Rating

- During the time study, time study engineer carefully observes the performance of the operator. This performance seldom conforms to the exact definition of normal or standard. Therefore, it becomes necessary to apply some 'adjustment' to the mean observed time to arrive at the time that the normal operator would have taken to do that job when working at an average pace. This 'adjustment' is called Performance Rating.
- Determination of performance rating is an important step in the work measurement procedure. It is based entirely on the experience, training, and judgment of the work-study engineer. It is the step most subjective and therefore is subject to criticism.
- Performance Rating can be defined as the procedure in which the time study engineer compares the performance of operator(s) under observation to the Normal Performance and determines a factor called Rating Factor.
  - Rating Factor = Observed Performance / Normal Performance

Performance Rating- Example

A work cycle has been divided into 8 elements and time study has been conducted. The average observed times for the elements are given in the following Table:

Element No.	1	2	3	4	5	6	7	8
Element Type	M	M	P	M	M	M	M	M
Average actual time (minutes)	0.14	0.16	0.30	0.52	0.26	0.45	0.34	0.15

P = Power Controlled M = Manually Controlled

- Total observed time of work cycle = 2.32 min.
- Suppose we select three elements 2, 5 and 8 (These must be manually controlled elements). By using some PMT system, suppose we determine the times of these elements as

Elements No.	2	5	8
PMT System times (min)	0.145	0.255	0.145

Performance Rating- Example

- Rating factor for element 2 = 0.145 / 0.16 = 90.62 %.
- Rating factor for element 5 = 0.255 / 0.26 = 98.08 %.
- Rating factor for element 8 = 0.145 / 0.15 = 96.66 %.
- The mean of the rating factors of selected elements = 95.12 % or say 95 % is the rating factor that will be used for all the manual elements of the work cycle.
- The normal time of the cycle can than be calculated

Element No.	1	2	3	4	5	6	7	8
Element Type	M	M	P	M	M	M	M	M
Average actual time (min)	0.14	0.16	0.30	0.52	0.26	0.45	0.34	0.15
PMT system time (min)		0.145			0.255			0.145
Performance Rating Factor	95	95	100	95	95	95	95	95

- Normal Cycle Time = 0.95 (0.14+0.16+0.52+0.26+0.45+0.34+0.15) +1.00(0.30) =1.92+0.30 =2.22 minutes
- It is to be noted that power controlled (or machine-paced) elements are always given 100% rating.

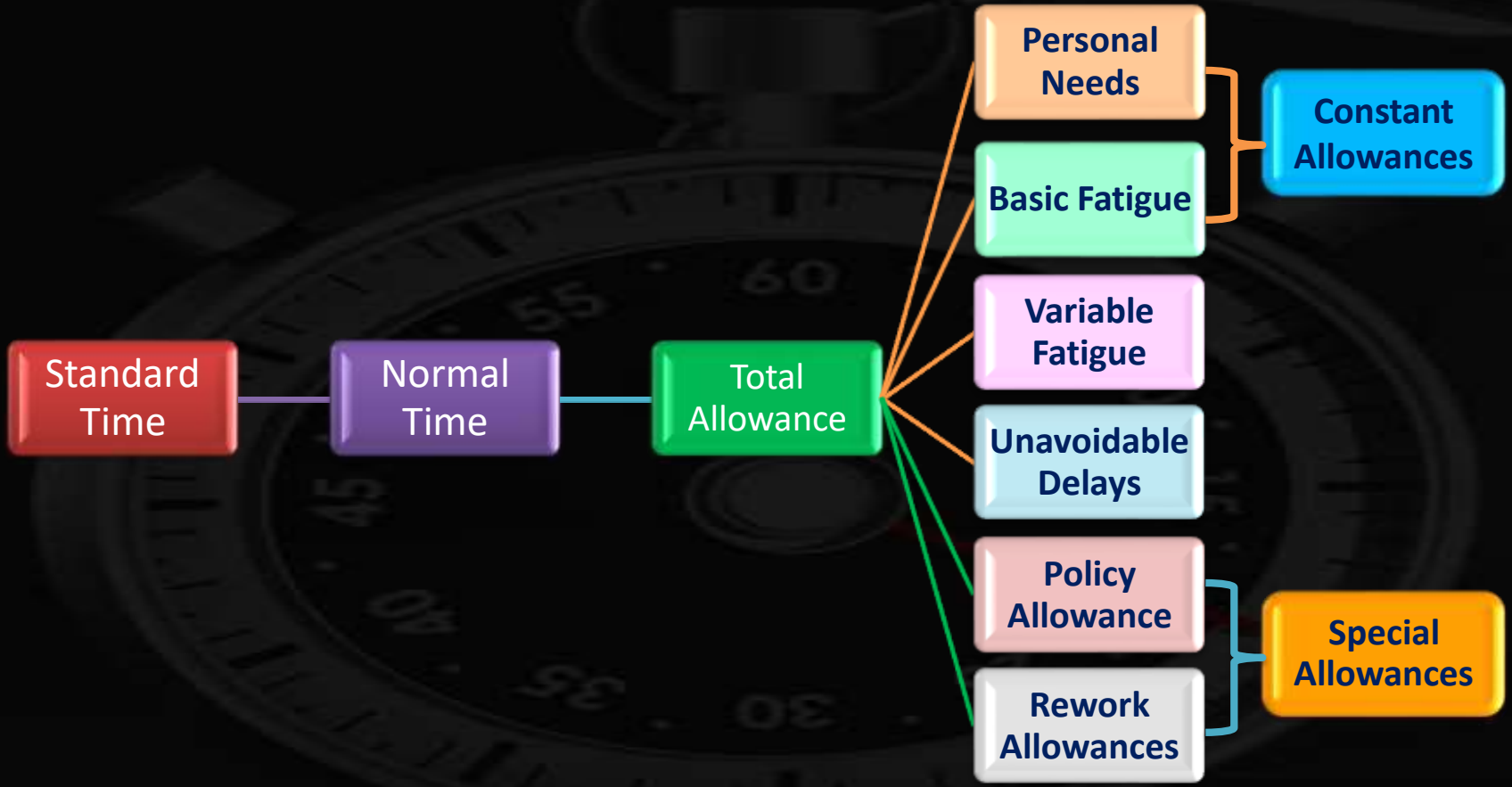
Allowances

- The readings of any time study are taken over a relatively short period of time.
- The normal time arrived at, therefore, does not include unavoidable delay and other legitimate lost time, for example, in waiting for materials, tools or equipment; periodic inspection of parts; interruptions due to legitimate personal needs, etc.
- It is necessary and important that the time study person applies some adjustment, or allowances, to compensate for such losses so that fair time standard is established for the given job.
- Allowances are generally applied to total cycle time as some percentage of it, but sometimes these are given separately for machine time as some % and for manual effort time some other %. However, no allowances are given for interruptions which may be due to factors which are within the operator's control or which are avoidable.

Most companies allow the following allowances to their employees.

- Constant allowances (for personal needs and basic fatigue)
- Delay Allowance (for unavoidable delays)
- Fatigue Allowance (for job dependent fatigue)
- Personal Allowance
- Special Allowance

Various Allowances To Build Standard Time



Example- Standard Time

In making a time study of a laboratory technician performing an analysis of processed food in a canning factory, the following times were noted for a particular operation.

Run	1	2	3	4	5	6	7	8	9	10	11	12
Operation time (sec.)	21	21	16	19	20	16	20	19	19	20	40	19
Run	13	14	15	16	17	18	19	20	21	22	23	24
Operation time (sec.)	21	18	23	19	15	18	18	19	21	20	20	19

- Determine the normal time.
- Determine the standard time.
- Watch readings falling 50 % above and 25 % below the average may be considered as abnormal.

Example- Standard Time

$$T_{av} = \frac{\Sigma \text{cycle time}}{\text{No. of cycles}} = \frac{481}{24} = 20.04 \text{ s.}$$

$$1.5\,T_{av} = 30 \text{ s.}$$

$$0.75\,T_{av} = 15 \text{ s.}$$

Discarding the time values which are greater than $1.5\,T_{av}$ or less than $0.75\,T_{av}$,

the average observed cycle time $= \frac{441}{23} = 19.2$ s.

$$\text{Normal time} = 19.2 \times \frac{120}{100} = 23.04 \text{ s.}$$

Standard time = normal time + allowances

$$= 23.04 \times \frac{100}{100 - 13}$$

$$= 26.5 \text{ seconds.}$$

Work Sampling

- Work Sampling is a technique of getting facts about utilization of machines or human beings through a large number of instantaneous observations taken at random time intervals.
- The ratio of observations of a given activity to the total observations approximates the percentage of time that the process is in that state of activity.
- For example, if 500 instantaneous observations taken at random intervals over a few weeks show that a lathe operator was doing productive work in 365 observations and in the remaining 135 observations he was found 'idle' for miscellaneous reasons, then it can be reliably taken that the operator remains idle (135/500) x 100 = 27 % 0f the time.
- Obviously, the accuracy of the result depends on the number of observations. However, in most applications there is usually a limit beyond which greater accuracy of data is not economically worthwhile.

Use of Work Sampling for Standard Time Determination

- Work sampling can be very useful for establishing time standards on both direct and indirect labor jobs. The procedure for conducting work sampling study for determining standard time of a job can be described step-wise.

Work Sampling

- Work sampling was originally developed by l.H.C. Tippett in britain in 1934 for the British cotton industry research board.
- ***Definition:-***

  A technique in which a statistically competent number of instantaneous observations are taken, over a period time, of a group of machines, processes or workers.
- ***Work sampling has three main applications:-***

1. **Activity and delay sampling:-** to measure the activities and delays of workers and machines.
2. **Performance sampling:-** to measure working time and non-working time of a person on a manual work and to establish a performance index or performance level for a person during his working time.
3. **Work measurement:- u**nder certain circumstances, to measure manual task that is to be established a time standard for an operation.

Work Sampling

- Work sampling can be very useful for establishing time standards on both direct and indirect labor jobs.
- The procedure for conducting work sampling study for determining standard time of a job can be described step-wise.

Step 1 . Define the problem.

- Describe the job for which the standard time is to be determined.
- Unambiguously state and discriminate between the two classes of activities of operator on the job: what are the activities of job that would entitle him to be in 'working" state.
- This would imply that when operator will be found engaged in any activity other than those would entitle him to be in "Not Working" state.

Work Sampling

Step 2. Design the sampling plan.

- Estimate satisfactory number of observations to be made.
- Decide on the period of study, e.g. two days, one week, etc.
- Prepare detailed plan for taking the observations.
- This will include observation schedule, exact method of observing, design of observation sheet, route to be followed, particular person to be observed at the observation time, etc.

Step 3. Contact the persons concerned and take them in confidence regarding conduct of the study.

Step 4. Make the observations at the pre-decided random times about the working / not working state of the operator.

- When operator is in working state, determine his performance rating.
- Record both on the observation sheet.

Step 5. Obtain and record other information.

- This includes operator's starting time and quitting time of the day and total number of parts of acceptable quality produced during the day.

Step 6. Calculate the standard time per piece.

Work Sampling- Advantages

- Many operators or activities which are difficult or uneconomical to measure by time study can readily be measured by work sampling.
- Two or more studies can be simultaneously made of several operators or machines by a single study person. Ordinarily a work study engineer can study only one operator at a time when continuous time study is made.
- It usually requires fewer man-hours to make a work sampling study than to make a continuous time study. The cost may also be about a third of the cost of a continuous time study.
- No stopwatch or other time measuring device is needed for work sampling studies.
- It usually requires less time to calculate the results of work sampling study. Mark sensing cards may be used which can be fed directly to the computing machines to obtain the results just instantaneously.
- A work sampling study may be interrupted at any time without affecting the results.
- Operators are not closely watched for long period of time. This decreases the chance of getting erroneous results for when a worker is observed continuously for a long period, it is probable that he will not follow his usual routine exactly during that period.
- Observations may be taken over a period of days or weeks. This decreases the chance of day-to-day or week-to-week variations that may affect the results.
- Work sampling studies are preferred to continuous time study by the operators being studied. Some people do not like to be observed continuously for long periods of time.
- Work sampling studies are less fatiguing and less tedious to make on the part of time study engineer.

Work Sampling- Disadvantages

1. Work sampling is not economical for the study of a single operator or operation or machine. Also, work-sampling study may be uneconomical for studying operators or machines located over wide areas.
2. Work sampling study does not provide elemental time data.
3. The operator may change his work pattern when he sees the study person. For instance, he may try to look productive and make the results of study erroneous.
4. No record is usually made of the method being used by the operator. Therefore, a new study has to be made when a method change occurs in any element of operation.
5. Compared to stop watch time study, the statistical approach of work sampling study is difficult to understand by workers.

Standard Data

- Standard data are elemental time standards taken from time studies of elements or group of elements that are alike.
- These are classified and filed so that they can be readily used when necessary.
- Housewives normally count predetermined number(s) of whistles from a pressure cooker boiling potato or rice.
- This counting help housewives to avoid opening the cooker a number of times to check the readiness of the cooking item within the cooker.
- Standard data refers to all the tabulated elemental standards that are being compiled to allow the measurement of a specific job without the necessity of a timing device such as the stopwatch
- The elemental times required for common operations (fitting screw, milling 10 mm gears, etc) may therefore be tabulated for future reference of like works.
- With standard data for constant handling elements and calculated variable time values for machine elements, it is possible to determine with the time standard for a given operation without time study

Standard Data

Standard data have many advantages. Few of them are listed below :

a) They help in reducing the number of time studies required.

b) They help in shortening the time needed to set the standard.

c) They support in bringing greater accuracy and consistency in time standards for a given class of work.

d) Standard data may be applied more quickly on a new work than by stopwatch study.

e) They allow the establishment of standards on indirect labour operations

PMTS

- A predetermined motion time system consists of a set of time data, which has been developed from many observations of a Wolter's performance.
- This is based on the analysis of work into its basis or elemental body motions that are called Therbligs.
- These observations are usually taken under controlled conditions such as close or far and easy or difficult.
- On the basis of exhaustive observations and time studies, a time standard has been assigned to each therblig classification.
- Predetermined motion times are known as synthetic basic motion times.
- The times values are synthetic in that they are often logical combinations of Therbligs, and basic in that further refinement or sub-division is not only difficult but impractical.
- PMTS (as per the British Standard) is defined as : A work measurement technique which establishes times for basic human motions for a job at a defined level of performance.

PMTS

- The main use of PMTS lies in the estimation of time for the performance of a task before it is performed. The procedure is particularly useful to those organizations which do not want troublesome performance rating to be used with each study.

Applications of PMTS are for

i. Determination of job time standards.
ii. Comparing the times for alternative proposed methods so as to find the economics of the proposals prior to production run.
iii. Estimation of manpower, equipment and space requirements prior to setting up the facilities and start of production.
iv. Developing tentative work layouts for assembly lines prior to their working in order to minimize the amount of subsequent re-arrangement and re-balancing.

PMTS- Advantages

Advantages:

1. There is no need to actually observe the operation running. This means the estimation of time to perform a job can be made from the drawings even before the job is actually done. This feature is very useful in production planning, forecasting, equipment selection, etc.
2. The use of PMT eliminates the need of troublesome and controversial performance rating. For the sole reason of avoiding performance rating, some companies have been using this technique.
3. The use of PMT forces the analyst to study the method in detail. This sometimes helps to further improve the method.
4. A bye-product of the use of PM times is a detailed record of the method of operation. This is advantageous for installation of method, for instructional purposes, and for detection and verification of any change that might occur in the method in future.
5. The PM times can be usefully employed to establish elemental standard data for setting time standards on jobs done on various types of machines and equipment.
6. The basic times determined with the use of PMT system are relatively more consistent.

PMTS- Disadvantages

1. Its application to only manual contents of job
2. The need of trained personnel. Although PMT system eliminates the use of rating, quite a bit of judgment is still necessarily exercised at different stages.
3. Standard time data is not available for each activity of every worker.
4. Intensive training of very long period under the supervision of experienced work study man is required to apply PMTS.
5. PMTS has limited applications is non-repetitive production activities.

PMTS Levels and Generations

- Chronologically, first-level PMT systems were the first to be developed, and then second - and higher - level systems were subsequently constructed based on the first-level systems.
- Because of this chronological development of the systems, the level of the system usually corresponds to the generation of the system.
- First-level PMT systems are called first generation systems, and the subsequent systems are second and third generations.
- For example, MTM-1 is first generation MTM-2 is second generation and is based on MTM-1. MTM-3 is a third generation MTM system.

Characteristics of PMT system levels

Characteristics	*Basic Level PMTS*	*Higher Level PMTS*
Accuracy	Most accurate	Less accurate
Application Time	Much time to set standards	Less time to set standard
Suited to specific types of tasks	Highly repetitive	Repetitive or batch
Cycle times	Short cycle (e.g 1 min)	Longer cycle time feasible
Motion elements	Basic motions	Aggregates basic motions
Method description	Very detailed	Less detailed, easier to apply
Flexibility of application	Highest flexibility	Less flexibility

Maynard Operation Sequence Technique (MOST)

- Developed in Sweden by Zandin
- The vast majority of activities involved with the handling of an object were associated with a limited number of motion sequences
- By taking advantage of this point, the time required to perform an analysis is significantly reduced from that required by MTM without a reduction in precision.

Maynard Operation Sequence Technique (MOST)

- Kjell Zandin, while working in the Swedish Division of H. B. Maynard in the late 1960's, detected striking similarities in the sequence of MTM defined motions whenever an object was handled.
- Under MOST, the primary work units are no longer basic motions as in MTM, but collections of these basic motions dealing with moving object.
- The Maynard Operation Sequence Technique (MOST) is a high-level predetermined motion time system (PMTS) that is based on MTM (Methods Time Measurement).
- MOST is a work measurement technique that concentrates on the movement of objects. It is used to analyze work and to determine the normal time that it would take to perform a particular process /operation.
- The basic version of MOST which is now referred to as Basic MOST.

Maynard Operation Sequence Technique (MOST)

- Most predetermined motion time systems use **time measurement units** (TMU) instead of seconds for measuring time.
- One TMU is defined to be 0.00001 hours, or 0.036 seconds.
- These smaller units allow for more accurate calculations without the use of decimals. 1 hr = 100,000 TMU
- MOST makes the assumption that to move an object, a standard sequence of events occurs.

Maynard Operation Sequence Technique (MOST)

- More specifically, MOST is used to:

1. Break down the operation/process into smaller steps/units
2. Analyze the motions in each step/unit by using a standard MOST method sequence
3. Assign indices to the parameters constituting the method sequence for each task
4. Sum up the indices to arrive at a time value for each step/unit
5. Sum up the time values for all the steps/units to arrive at the 'normal time' required to perform that operation/process

MOST

- Four Sequence Models
  - General Move, Controlled Move, Tool Use, Manual Crane
- They are picked up and moved freely through space -- the GENERAL MOVE.
- They are moved and maintain contact with another surface -- the CONTROLLED MOVE.
- The MOST Family
  - Basic MOST -- General Operations
  - Mini MOST -- Repetitive Operations
  - Maxi MOST -- Non-repetitive Operations
  - Clerical MOST -- Clerical Operations

MOST

- MiniMOST
  - for short-cycle, highly repetitive operations
  - This system requires more time
  - Mini MOST is used to analyze operations likely to be repeated more than 1500 times per week.
- MaxiMOST
  - For long-cycle times, with many non-identical operations
  - Used to analyze operations that are likely to be performed less than 150 times per week.
- Basic MOST
  - Basic MOST is used for operations that are likely to be performed more than 150 times but less than 1500 times per week.
  - General Move Sequence
    - Three components: Get, Put, Return
    - Example
      - GET: A1 B0 G1
      - PUT: A1 B0 P3
      - RETURN: A1

MOST in the Work Pyramid

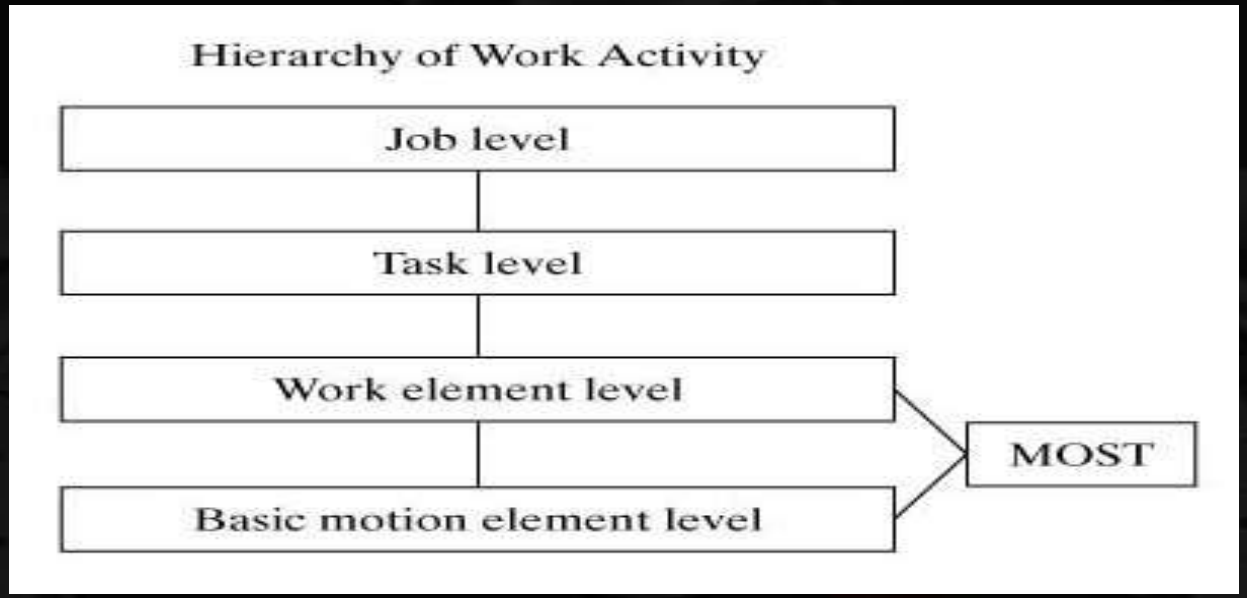


Figure - The position of the Basic MOST activity sequence model in our work hierarchy

Basic MOST

- The focus of Basic MOST is on work activity involve the movement of objects. The majority of industrial manual work does involve moving objects (e.g., parts, tools) from one location to another in the workplace.
- Basic MOST uses motion aggregates (collections of basic motion elements) that are concerned with moving things. The motion aggregates are called activity sequence models in Basic MOST.
- There are three activity sequence models in Basic MOST, each of which consists of a standard sequence of actions:
  - General move. This sequence model is used when an object is moved freely through space from one location to the next (e.g., picking something up from the floor and placing it on a table).
  - Controlled move. This sequence model is used when an object is moved while it remains in contact with a surface (e.g., sliding the object along the surface) or the object is attached to some other object during its movement (e.g., moving a lever on a machine).
  - Tool use. This sequence model applies to the use of a hand tool (e.g., a hammer or screwdriver).

Basic MOST

- The actions in an activity sequence model, called sequence model parameters in Basic MOST, are similar to basic motion elements in MTM. Let us examine the three sequence models and indicate the standard sequence of model parameters for each.

General Move. The General Move sequence is applicable when an object is moved through the air from one location to another. There are four parameters (actions) in the General Move, symbolized by letters of the alphabet:

- A — Action distance, usually horizontal. This parameter is used to describe movements of the fingers, hands, or feet (e.g., walking). The movement can be per formed either loaded or unloaded.
- B — Body motion, usually vertical. This parameter defines vertical body motions and actions (e.g., sitting, standing up).
- G — Gain control. This parameter is used for any manual actions involving the fingers, hands, or feet to gain physical control of one or more objects. ft is closely related to the grasp motion element in MTM (e.g., grasp the object).
- P — Placement. The placement parameter is used to describe the action involved to lay aside, position, orient, or align an object after it has been moved to the new location (e.g., position the object).

Basic MOST

- These parameters occur in the following standard sequence in the General Move:

A	B	G	A	B	P	A
Action distance	Body motion	grasp	Action distance	Body motion	Placement	Action distance

- where the first three parameters (A B G) represent basic motions to get an object, the next three parameters (A B P) represent motions to put or move the object to a new location, and the final parameter (A) applies to any motions at the end of the sequence, such as return to original position.
- To complete the activity sequence model, each parameter is assigned a numerical value in the form of a subscript or index number that represents the time to accomplish that action.

Basic MOST

- The value of the index number depends on the type of action, its motion content, and the conditions under which it is performed. Table 14.6 lists the parameters and possible circumstances for the action, together with the corresponding values of the index numbers.

- When the index values have been entered for all parameters, the time for the sequence model is determined by summing the index values and multiplying by 10 to obtain the total TMUs. The procedure is illustrated in the following example.

Example: General Move

- Develop the activity sequence model and determine the normal time for the following work activity: A worker walks 5 steps, picks up a small part from the floor, returns to his original position, and places the part on his worktable.

Basic MOST

- Solution: Referring to Table 14.6, the indexed activity sequence model for this work activity would be the following:

$$A_{10}\ B_6\ G_1\ A_{10}\ B_0\ P_1\ A_0$$

- where A_{10} = walk 5 steps, B_6 = bend and arise, G_1 = control of small part, A_{10} = walk back to original position, B_0 = no body motion, P_1 = lay aside part on table, and A_0 = no motion. The sum of the index values is 28. Multiplying by 10, we have 280 TMUs (about 10 sec).

General Move activity sequence model – **A B G A B P A**

Index	**A** = Action distance	**B** = Body motion	**G** = Gain control	**P** = Placement
0	Close ≤ 5 cm (2 in.)			Hold, Toss
1	Within reach (but > 2 in.)		Grasp light object using one or two hands	Lay aside Loose fit
3	1 or 2 steps	Bend and arise with 50% occurrence	Grasp object that is heavy, or obstructed, or hidden, or interlocked	Adjustments, light pressure, double placement
6	3 or 4 steps	Bend and arise with 100% occurrence		Position with care, or precision, of blind, or obstructed, or heavy pressure
10	5, 6, or 7 steps	Sit or stand		
16	8, 9, or 10 steps	Through door, or Climb on or off, or Stand and bend, or Bend and sit		

University Questions

1. State different steps involved in Method Study.
2. What are the steps involved in micro-motion study. Describe five Therbligs with their symbol, code, color and description.
3. Define the term Element. What are the reasons for breaking job into elements? What are the different types of elements?
4. Define micro motion study. What are Therbligs? When it is used? List Therbligs symbol, color description, name and code.
5. Explain the following in connection with time study: 1.selecting the job 2.selection of worker 3. breaking the jobs in to the element 4. no. of cycles to be timed
6. Draw a two hand process chart considering the example of assembly of “Nut & Bolt”
7. Define Rating. Why is it necessary to apply rating to the actual time which an operator takes to perform an operation?
8. Explain the following factors in relation to the selection of job for method study. i) Economic considerations, ii) Human considerations.

University Questions

9. What is work measurement? Enlist various techniques of work measurement and explain PMTS in detail.
10. What are the different time study equipments
11. What are the principles of motion economy?
12. What is multiple activity chart?
13. What are the different steps of micro motion study?
14. Explain micro and macro motion study techniques in details.
15. Explain Therbligs in details with the symbols used and inferences drawn.
16. Short note- cycle graph and chronocycle graph.
17. Draw and explain outline process chart, construction, usages, inference for the replacement of spark plug.
18. List various work measurement techniques and discuss anyone in detail.
19. Why work study is valuable for production management? Define work study, Method study and work measurement.

University Questions- Numerical

1. The work study engineer carries out the work sampling study. The following observations were made for the machine shop. Compute the standard time for the job.

    1. The duration of study - 120 hours, Total number of observations – 7000, No. of idle activities – 1200, Ratio of manual to machine element - 3 : 1, Average rating factor - 120 %, Total no. of jobs produced during study - 800 units, Rest and personal allowances - 17 %

Answer:-

- Overall time per unit (To) = (Duration of study / Number of jobs produced during study) = (120 x 60) / 800 = 9 min.
- Production observation= Total number of observations - No. of idle activities = 7000-1200=5800

1. Effective time per piece (Te) = T0 × (Production observation / Total observation) = 9 × (5800 /7000) = 7.46 min.
2. The effective time is to be segregated into manual time and machine element time.
3. Machine controlled time per piece (Tm) = 7.46 × 1/4 = 1.87 min
4. Hand controlled time per piece (Th) = 7.46 × 3/4 = 5.59 min
5. Normal time per piece = Tm + Th × performance rating = 1.87 + 5.59 × 1.2 = 8.58 min.
6. Standard time per piece = 8.58 (1 + 0.17) = 10.04 minutes.

University Questions- Numerical

2. The workmen in an engineering firm are expected to work for 400 minutes in a shift of 8 hours. The remaining time is meant for Rest and personal allowances

    1. Compute the standard time per piece of a job whose normal time is 2 minutes.
    2. Find number of pieces to be produced per day
    3. If the workmen engaged on the above job produced 180 pieces in the shift, what is their efficiency?

Answer

Total minutes in a shift =8×60=480 minutes

Normal Time =2 minutes

Allowances =480−400=80 minutes

Percentage Allowance =Rest timing ×100 Available work timing=80×100/400=20%

1. Standard Time= Normal time (1+ % Allowances)= 2 (1+0.20)= 2.4 minutes

2. No. of pieces produced per day = 480/2.4= 200

3. Efficiency= 180/200= 90%

University Questions

3. An operation involves the following elements given below with their relevant data. Assuming rest and personal allowances as 12% and contingency allowances as 2%, calculate the standard time for the operation

Element	Observed time (minutes)	Rating	Remark
A	0.2	90	-
B	0.05	80	-
C	0.03	100	-
D	0.78	100	-
E	0.06	100	-
F	0.05	100	-
G	0.02	85	Once in 5 piece
H	0.06	80	-
I	0.1	90	-
J	0.04	90	Once in 20 piece

University Questions

Normal time for each component can be computed as follows

Element	Observed time (minutes)	Rating	Frequency	Normal time
A	0.2	90	1	0.080
B	0.05	80	1	0.040
C	0.03	100	1	0.030
D	0.78	100	1	0.7800
E	0.06	100	1	0.0600
F	0.05	100	1	0.0500
G	0.02	85	1/5	0.0340
H	0.06	80	1	0.0480
I	0.1	90	1	0.0900
J	0.04	90	1/20	0.0180

Normal Time for the operation
= 1.330
Standard Time
= Normal Time + Allowances
= 1.330(1+0.14)
= 1.5162 min

University Questions

4. A work sampling study was conducted for 100 hours in the machine shop in order to estimate the standard time. The total number of observations was 2500, No. of working activity could be noticed for 400 observations. The ratio between manual and machine elements was 2:1. average rating factor was estimated as 1.15 and total number of articles produced during the study period was 6000. rest and personal allowances are 12% of the normal time. Estimate standard time to perform the operation.

Answer:

- Overall time per unit (To) = (Duration of study / Number of jobs produced during study) = (100 x 60) / 6000 =1 min.
- Production observation= Total number of observations - No. of idle activities = 2500-400=2100

1. Effective time per piece (Te) = T0 × (Production observation / Total observation) = 1 × (2100 /2500) = 0.84 min.
2. The effective time is to be segregated into manual time and machine element time.
3. Machine controlled time per piece (Tm) = 0.84 × 1/3 = 0.28 min
4. Hand controlled time per piece (Th) = 0.84 × 2/3 = 0.56 min
5. Normal time per piece = Tm + Th × performance rating = 0.28 + 0.56 × 1.15 = 0.924 min.
6. Standard time per piece = 0.924 (1 + 0.12) = 1.03488 minutes.

University Questions

5. A time study was conducted on a job considering of three elements. Stop watch reading in hundredth of minute is given. Using cumulative method, Calculate standard time if allowances is 17%.

Element	Stop watch reading					Rating
	I	II	III	IV	V	
A	10	73	139	203	266	80
B	25	88	155	218	280	100
C	64	128	193	257	320	110

Answer: As we are Using cumulative method, the individual timing for element is computed by subtracting proceeding reading from successive figures as shown in table . Eg. 25-10= 15 for element B

Element	Stop watch reading					Avg. Time	Rating	Normal Time
	I	II	III	IV	V			
A	10	09	11	10	09	0.098	80	0.0784
B	15	15	16	15	14	0.150	100	0.1500
C	39	40	38	39	40	0.392	110	0.4312
							Total	0.6596

Standard Time
= 0.6596 (1+0.17)
= 0.7717 minutes