Department of Mechanical Engineering
B.E. Semester – VI
Industrial Engineering (2161907)
List of Experiments

Sr. No.	Title	Date of Performance	Date of submission	Sign	Remark
1	To Study & Prepare Operation Process Chart (OPC) for given assembly.				
2	To Study & Prepare Flow Process Chart and Flow Diagram for given assembly for OPC.				
3	To study & Prepare Man-Machine Chart for the given situation.				
4	To study & Calculate co-efficient of correlation for time study person using performance rating technique.				
5	To study & Calculate standard time for given job.				
6	To study & Prepare a frequency Distribution Curve for the data source given.				
7	To study & Construct X bar- R Chart for given process.				
8	To study & Construct P-chart for given process.				
9	To study & Construct C-chart for given process.				
10	To study about Sampling Plans & Decide about acceptance or rejection of a particular product using sampling plans.				
11	Tutorial – 1: Example solved on plant layout				
12	Tutorial – 1: Example solved on Forecasting				

EXPERIMENT NO: - 01

AIM: To Study & Prepare Operation Process Chart (OPC) for given assembly.

OBJECTIVES: After completing this experiment, you will be able to:

- Identify operations and inspections.
- List the operations and inspections involved in manufacturing process of each part of an assembly or processes.
- Note down details about materials, machines and equipment used for each component of an assembly.
- To understand sub assembly and assembly procedure.
- Construct Operation (Outline) Process Chart.

Introduction: -

Work Study: - It is a generic term for those techniques, particularly method study and work.
Method Study: - Method study is the systematic recording and critical examination of existing and proposed ways of doing work, as a means of developing and applying easier and more effective methods and reducing costs.

Work Measurement: - Work measurement is the application of techniques designed to establish the time for a qualified worker to carry out a specified job at defined level of performance.
[Work Study by ILO page no; 28, 29]

Thus work study is a management technique to increase productivity and is divided into two broader concepts Method Study and Work Measurement.

As per the definition of method study the main objective, is to improve the existing method of doing work and to develop more effective and economical method. Method study uses different methods to record the data.

The most commonly used method study charts and diagrams are as follows:

A. Charts: ***Indicating process SEQUENCE***
Outline Process Chart,
Flow Process Charts (Man, Material & Equipment type)
Two handed process Chart.

B. Charts: ***using a Time Scale***
Multiple Activity Chart (Man-Machine Chart)
SIMO Chart

C. Diagrams: ***Indicating movement***
Flow Diagram
String Diagram
Cycle graph
Chrono cycle graph Travel Chart.

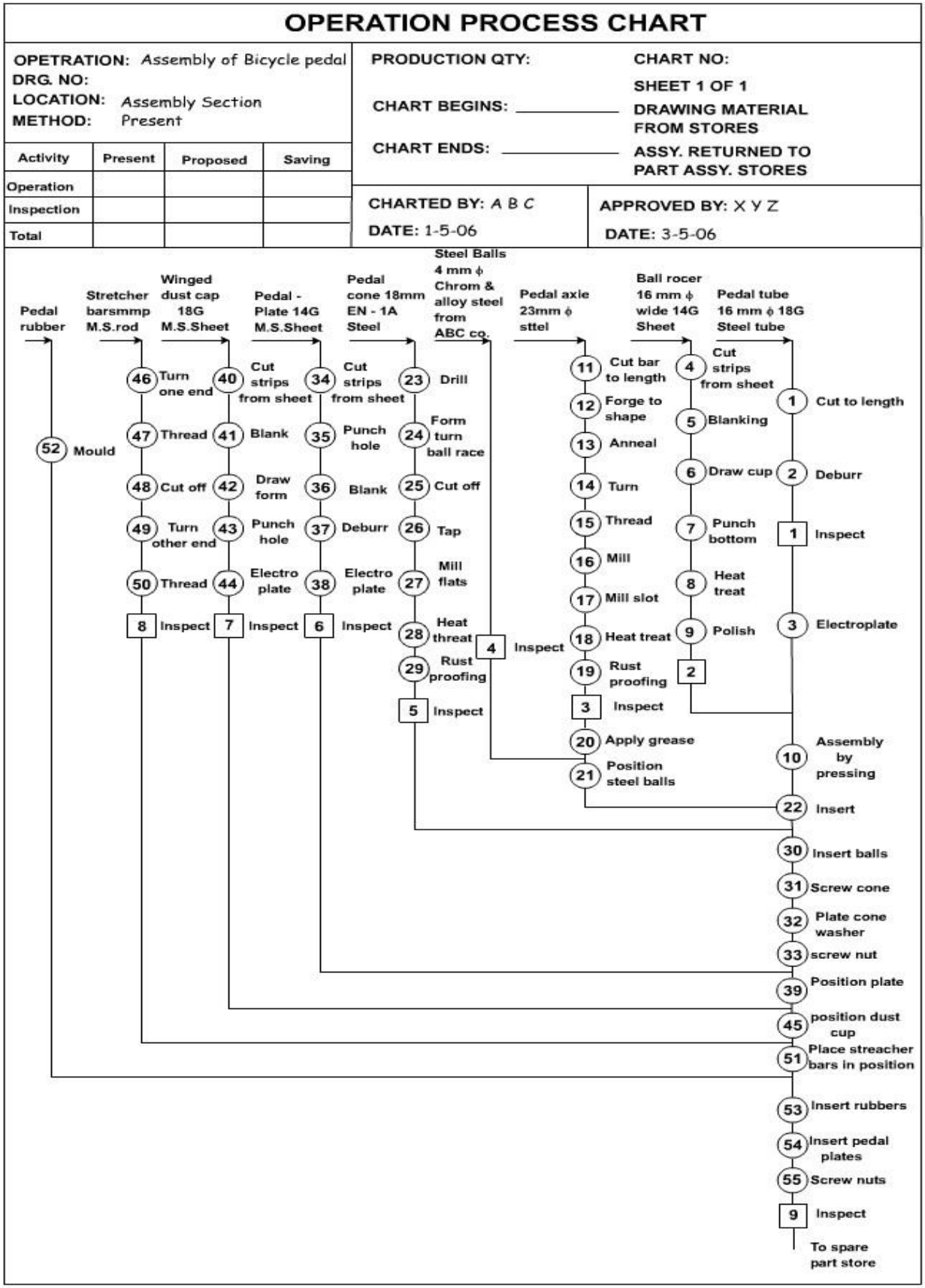
In this experiment we are going to study about Operation (Outline) Process Chart.

Operation (Outline) Process Chart: It is a process chart giving an overall picture by recording in sequence only the main operations and inspections. In an outline process chart, only the principal operations are carried out and the inspections made to ensure their effectiveness are recorded, irrespective of who does them and where they are performed. In preparing such a chart, only the symbols for 'operation' and 'inspection' are necessary.

Symbols used for Operation (Outline) Process Chart.

Operation: - The symbol for operation is as shown:
Operation indicates the main steps in a process, method or procedure. Usually the part, material or product concerned is modified or changed during the operation i.e. physical / chemical e.g. changing shape in machining, chemical change during chemical process; adding or subtracting during assembly or disassembly. When man type charts are produced operation is indicated when any activity or work is done by the man who is used for that particular scenario, for e.g. a clerical routine, an operation is said to take place when information is given or received, or when planning or calculating takes place.

Inspection: - The symbol for inspection is as shown:
Inspection indicates an inspection for quality and / or a check for quantity. e.g. measurement of dimension/values, etc., counting number of components etc., An inspection does not take place the material any nearer too becoming a completed product. It merely verifies that an operation has been carried out correctly as to quality and/or quantity, were it not for human shortcomings, most inspections could be done away with.
[Work Study by ILO page no: 70-72]

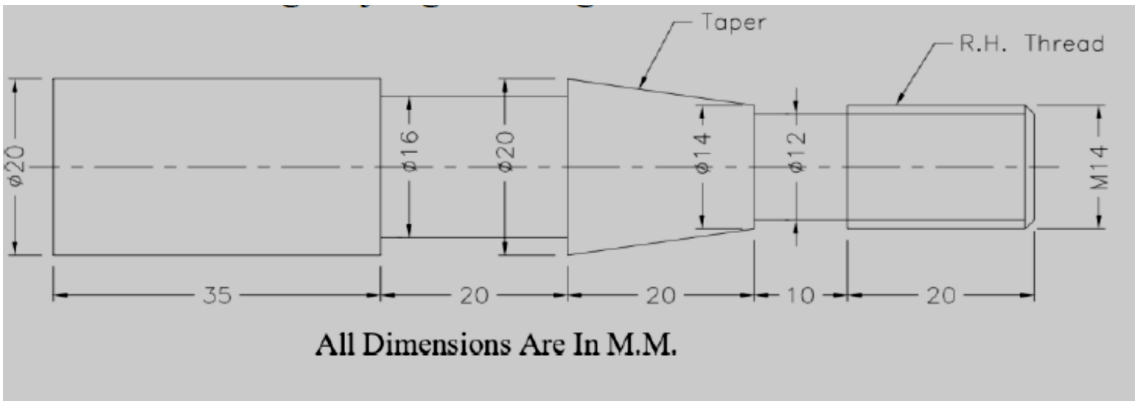


Operation process chart for assembly of bicycle pedal

Figure 1.1: Example of OPC for an assembly of bicycle pedal

Exercise: Construct OPC for the given assembly and situations.

1. Manufacturing blade assembly of table fan. Each blade consists of the following components: (i) Blade. (ii) Fixing plate. (iii) Three pieces of bolt and nut pairs. (iv) Six pieces of washers
2. Assembly of Nut Bolt and Washer
3. Writing a letter using a short hand typist. :
Chart Begins: Short Hand typist in his office awaiting for dictation.
Chart Ends: Short Hand typist put typed letter and its copies in Dispatch Tray.
4. For manufacturing the job given in figure. Construct for both material and machine tool used.



5. Repair of Car punctured tyre.

EXPERIMENT NO: - 02

AIM: To Study & Prepare Flow Process Chart (FPC) for given assembly.

OBJECTIVES: After completing this experiment, you will be able to:

- Identify operations, inspections, transportations, delays and storage.
- List the various activities involved in manufacturing process of each part of an assembly or processes.
- Decide the type of flow process chart to be constructed.
- To construct flow process chart to be constructed.
- Proposed improved flow process chart.
-

Introduction: -

Flow Process Chart: A flow process chart is a process chart setting out the sequence of the flow of a product or a procedure by recording all events under review using the appropriate process chart symbols.

Flow process chart is prepared in a manner similar to that in which the Outline Process chart is made, but using, in addition to the symbols for 'operation' and 'inspection', those for 'transport', 'delay' and 'storage'. Whichever the type of flow process charts is being constructed, the same symbols are always used and the charting procedure is very similar. In fact have only one printed form of chart for all the types of flow process charts.

Flow process charts contain more information than outline process chart because they indicate additionally, storage, delay and transportation also which represent a major portion of the product cost.

Types of Flow Process Charts: The following are the types of flow process chart:

1. Man Type: A flow process chart which records what the worker does.
2. Material Type: A flow process chart which records how material is handled or treated.
3. Equipment Type: A flow process chart which records how the equipment is used.

Symbols used for Operation (Outline) Process Chart.
Operation: - The symbol for operation is as shown:
Operation indicates the main steps in a process, method or procedure. Usually the part, material or product concerned is modified or changed during the operation i.e. physical / chemical e.g. changing shape in machining, chemical change during chemical process; adding or subtracting during assembly or disassembly. When man type charts are produced operation is indicated when any activity or work is done by the man who is used for that particular scenario, for e.g. a clerical routine, an operation is said to take place when information is given or received, or when planning or calculating takes place.

Inspection: - The symbol for inspection is as shown:
Inspection indicates an inspection for quality and / or a check for quantity. e.g. measurement of dimension/values, etc., counting number of components etc., An inspection does not take place the material any nearer too becoming a completed product. It merely verifies that an operation has been carried out correctly as to quality and/or quantity, were it not for human shortcomings, most inspections could be done away with.

Transport: - The symbol for transport is as shown:
Transport indicates the movement of workers, materials or equipment's from place to place.
A transport thus occurs when an object if moved from one place to another, except when such movements are part of an operation or are caused by the operations at the work station during an operation or an inspection.

Delay: - The symbol for delay is as shown:
Delay indicates a delay in the sequence of events: for example, work waiting between consecutive operations, or any object laid aside temporarily without record until required. Examples are worked stacked on the floor of a shop between operations, cases awaiting unpacking, parts waiting to be put into storage bins or a letter waiting to be signed.

Storage: - The symbol for storage is as shown:
Storage indicates a controlled storage in which material is received into or issued from a store under some form of authorization; or an item is retained for reference purposes.
[Work Study by ILO page no: 70-72]

FLOW PROCESS CHART	MATERIAL TYPE				
CHART NO:- 5 SHEET NO:- 5	S U M M A R Y				
Subject charted:-P.C.M.	ACTIVITY	PRESENT		PROPOSED	SAVING
	OPERATION ○	7			
ACTIVITY:-FLOW OF MELT IN PIG IRON CASTING MACHINE	TRANSPORT ⇨	6			
	DELAY D	1			
	INSPECTION □				
	STORAGE ▽				
METHOD:- PRESENT	TOTAL ACTIVITY	14			
LOCATION:-BLAST FURNACE,SAMAGHOGHA	TIME (man-min)				
:GUIDE BY:- KULDEEP BHATNAGAR	COST				
	LABOUR				
CHARTED BY:-Vimal Makwana	MATERIAL				
APPROVED BY:-	TOTAL				

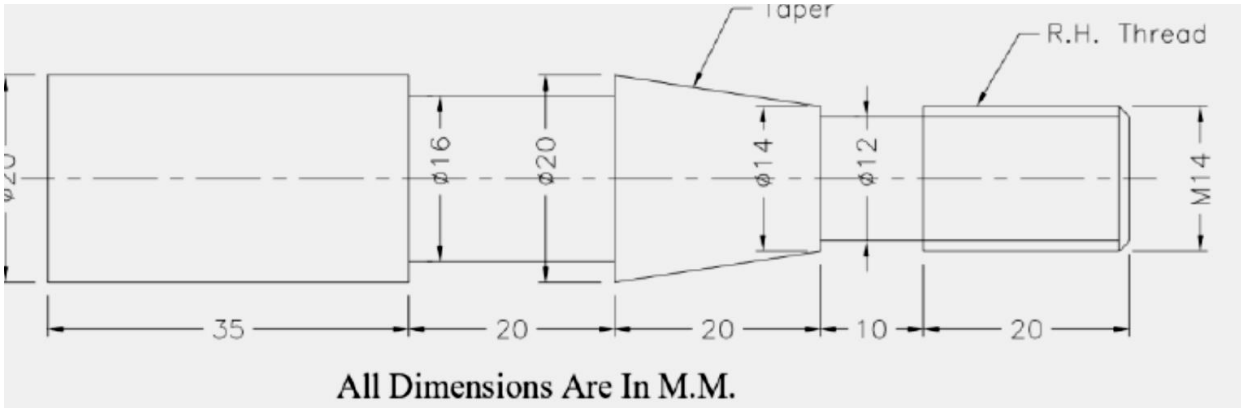
DESCRIPTION	QTY	DIST-ANCE	TIME (min)	SYMBOL ○	⇨	D	□	▽
POURING METAL FROM LADDLE								
FORWARD THE MELT TO MAIN RUNNER								
FORWARD THE MELT MAIN RUNNER TO SLAG CHUTE								
SLAG ARE COLLECTED BY SLAG CHUTE								
FORWARD THE MELT TO APRON PLATE								
OVERFLOW MELT WILL BE COLLECTED IN APRON PLATE [TWO STAND]								
TWO STAND PRODUCED CASTING FOR ROTATION								
CAST IS COOLED BY WATER								
SPRAY THE LIME ON CAST								
FORWARD THE CAST FOR DISCHARGE								
DISCHARE THE CAST								
WAITING FOR CRANE								
LOADING THE CAST BY MAGNETIC CRANE								
TRANSPORT THE CAST								
Total				7	6	1		

Figure 2.1: Example of Flow Process Chart (Material Type)

Exercise: Construct Flow Process for the given assembly and situations in the following format

1. Manufacturing blade assembly of table fan. Each blade consists of the following components: (i) Blade. (ii) Fixing plate. (iii) Three pieces of bolt and nut pairs. (iv) Six pieces of washers
2. Assembly of Nut Bolt and Washer
3. Writing a letter using a short hand typist.:
Chart Begins: Short Hand typist in his office awaiting for dictation.
Chart Ends: Short Hand typist put typed letter and its copies in Dispatch Tray.

4. For manufacturing the job given in figure. Construct for both material and machine tool used.



5. Repair of Car punctured tyre.

6. Construct a Flow Process Chart for the following:

i. Move bar stock from store to hacksaw	Dist. 8 meter
ii. Cutting of bar stock	Time 4 min
iii. Move to lathe machine	Dist. 6-meter
iv. Turning Process	Time 5 min
v. Move to milling machine	Dist. 7-meter
vi. Wait for milling machine	Time 2 min
vii. Milling keyway	Time 10 min

FLOW PROCESS CHART _____ TYPE

CHART NO:- SHEET NO:- OF:-	S U M M A R Y			
Subject charted:-	ACTIVITY	PRESENT	PROPOSE	SAVING
	OPERATION ○			
ACTIVITY:-	TRANSPORT ⇨			
	DELAY D			
	INSPECTION □			
	STORAGE ▽			
METHOD:-	DISTANCE (m)			
LOCATION:-	TIME (man-min)			
OPERATIVE(S):- CLOCK Nos:-	COST:-			
	LABOUR			
CHARTED BY:-	MATERIAL			
APPROVED BY:- DATE:-	TOTAL			

DESCRIPTION	TIME (min)	SYMBOL ○	⇨	D	□	▽	
TOTAL							

EXPERIMENT NO: - 03

AIM: To study & Prepare Man-Machine (Multiple Activity) Chart for the given situation

OBJECTIVES: After completing this experiment, you will be able to:

- Record the activities performed by the operator and machine.
- Identify independent, combined and idle activities.
- Construct man and machine chart.
- Calculate utilization for man and machine.
- Analyze the chart with a view to increase utilization.

Introduction: -

Man-Machine (Multiple Activity) Chart: A man-machine (multiple activity) chart is a chart on which the activities of more than one subject (worker, machine or item of equipment) are each recorded on a common on a common time scale to show their interrelationship. Man-Machine chart or multiple activity chart is a useful recording tool for situations where the work involves interactions of different subjects. One or more workers looking after different machines or a group of workers on loading materials at one point and dumping the same at a different point are some examples where this type of chart can be used effectively.
The fundamental difference between this tool and the other charts described in the previous section are as follows:

a. In man-machine (multiple activities) chart a time scale is used. No such time scale is used in the other charts.

b. Man-machine (multiple activity) charts can be used equally effectively even if there is no movement of workers involved in the work under consideration. The primary focus of this chart, for situations where the workers are moving as a part of their work, is to identify the idle time on the part of either the workers or the machines. The focus of other charts described so far were primarily to identify excess distances traversed by the workers, which is only indirectly related to the time. By using separate vertical columns, or bars, to represent the activities of different operatives or machines against a common time scale, the chart shows very clearly periods of idleness on the part of any of the subjects during the process. A study of the chart often makes it possible to rearrange these activities so that such ineffective time is reduced. The man- machine (multiple activity) chart is extremely useful in work involving repetitive operations. For a situation involving a worker handling different machines, this chart can be used to find the number of machines the worker can look after so as to minimize the cost

Example of Man-Machine (Multiple Activities) Chart: -

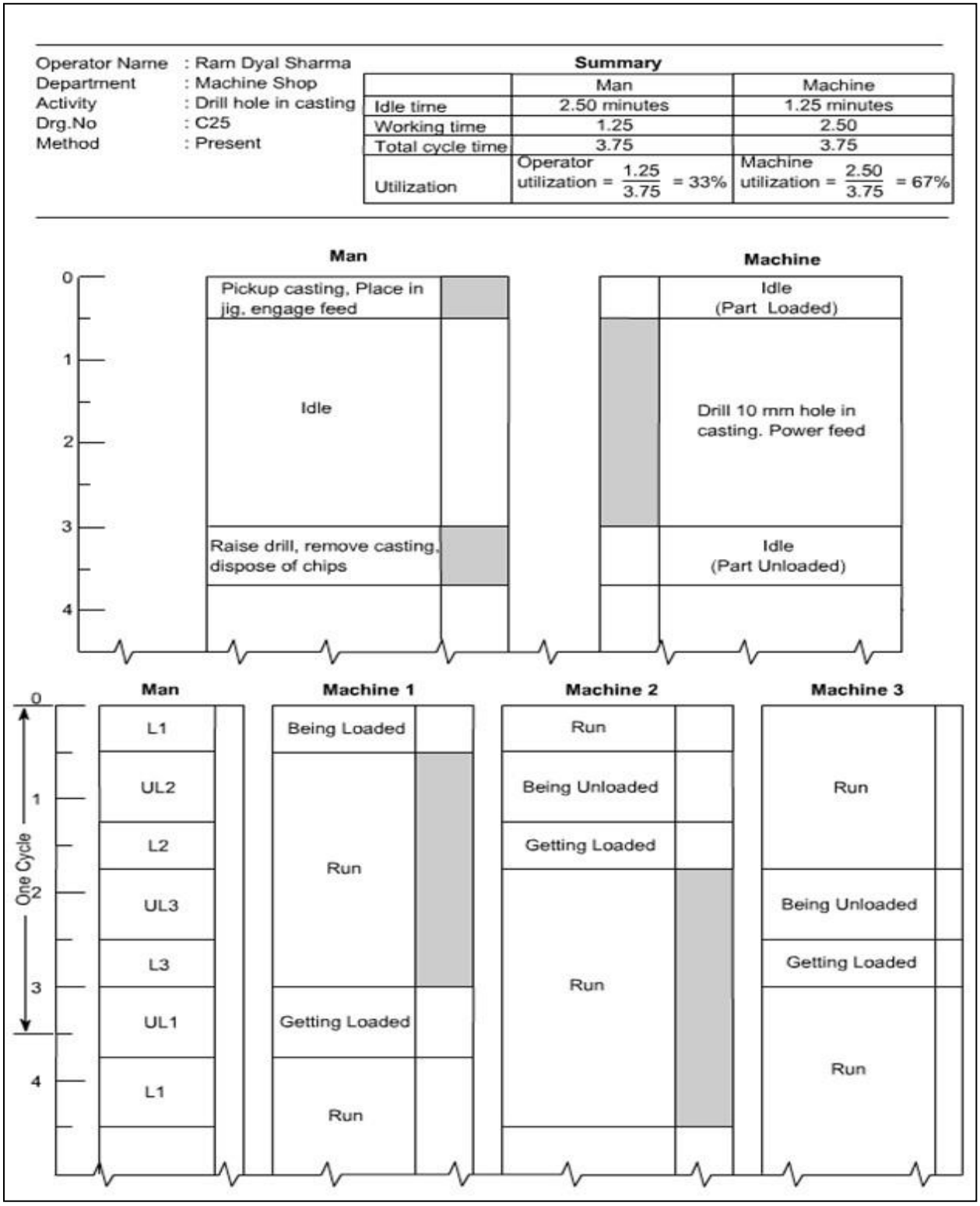


Figure 3.1: Example of Man- Machine (Multiple) Chart

The activities involved during the operations are classified as: -

1. Independent Activity:

Man: Operator working independently.

Machine: Auto feed, m/c working independently.

2. Combined Activity:

Man: Operator working with other operator or handling machine (hand feed).

Machine: Machine loaded or unloaded, servicing of machine.

3. Idle:

Man: Waiting for machine to complete operation.

Machine: Operator engaged in inspection, etc.

The color used to show various activities on man and machine chart are:

1. Green: For independent activity.

2. Orange: For combined activity.

3. Red: For idle time.

Exercise: Construct Man-Machine (Multiple Activity) Chart for the situations

1. Each of the two sides of a hand-operated toaster can be operated independently of the other. A spring holds each side of the toaster shut, and each side must be held open in order to insert bread. Assume that the toaster is hot and ready to toast bread. The following are the elemental times necessary to perform the operations. Assume also that both hands can perform their tasks with the same degree of efficiency.

- Place slice of bread in either side of toaster: 4 seconds.
- Toast either side of bread: 30 seconds.
- Turn slice of bread on either side of toaster: 2 seconds.
- Remove toast from either side of toaster: 4 seconds.
- By using an activity chart for toasting 3 slices of bread, what method would you recommend to obtain the best equipment utilization that is, the very shortest over-all time?

2. A chamfering, turning and threading operation is done on a job on lathe machine. Information of that operation is recorded as under. Show this information on man and machine chart.

i. Carry bar stock from the store.	1 min
ii. To fix the job in lathe chuck.	2 min
iii.To carryout manual turning of the job.	1.5 min
iv. To carryout chamfering operation on job	1 min
v. To carryout threading operation on job.	2 min
vi. To bring the saddle back and rearrange it	0.5 min
vii. To carryout threading work on the job.	1.5 min
viii. Inspection of the job.	1 min
ix. To remove the job from the lathe chuck.	0.5 min
x. Carrying completed work piece to store	1 min