Work Study
(Motion and Time Study)

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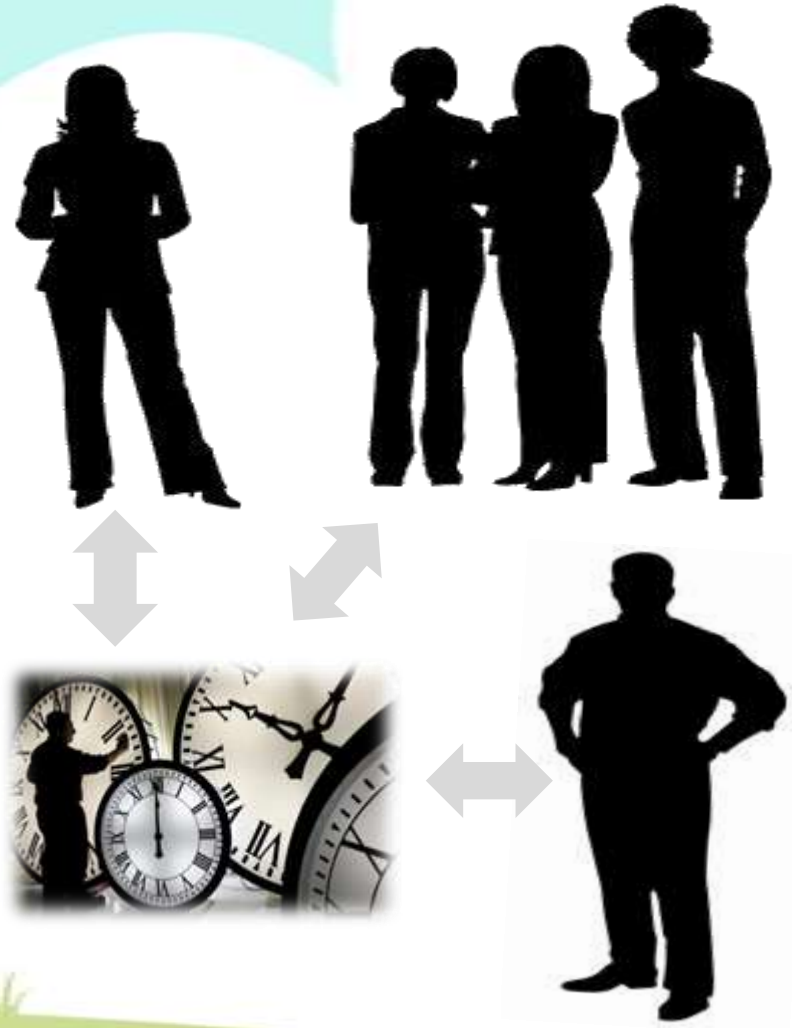
WORK STUDY

(International Labor Organization)

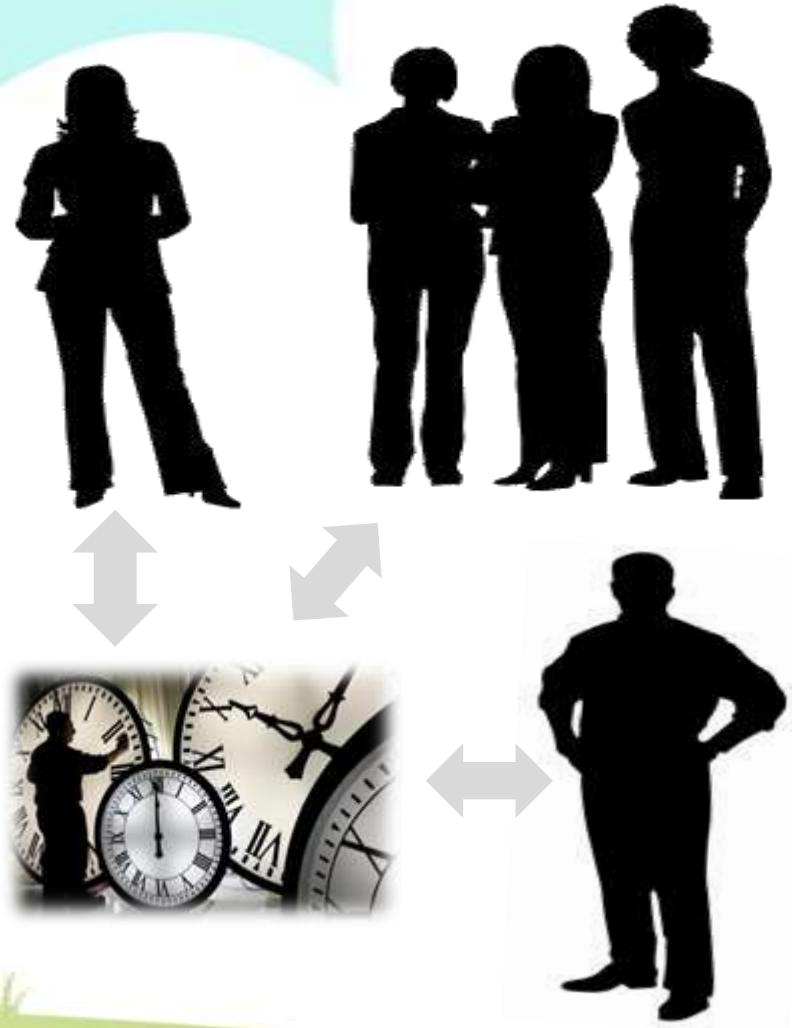
A term used to embrace the techniques of **method study** and **work measurement**, which are employed to ensure the best possible use of human and material resources in **carrying out specified activity**.



WORK STUDY

(British Standard Institute)

A generic term for those techniques, particularly **'method study'** and **'work measurement'**, which are used in the examination of **human work** in all its contexts and which lead systematically to the investigation of all factors which affect **the efficiency and economy** of the situation being renewed, in order to effect **improvement.**



G O A L S




ELIMINATE **COMBINE** **REARRANGE** **SIMPLIFY**

Do the right things (EFFECTIVE)
& Do the things right (EFFICIENT)


Importance of Work Study

- Guidance to understand the nature and true costs of work
- Assist management in reducing unnecessary costs
- Balancing work cells to make work flow smoother
- Learn the details of work and make improvement

History Of Work Study

- Frederick W. Taylor
- Frank & Lillian Gilbreth
- Prof. Elton Mayo
- Henry Laurence Gantt
- Toyota Production System

Why Labor ?

A major factor in the cost of a product

Eliminate Waste!

Source : www.adoptlean.com

9 Types of Waste . . .

Waiting

Overproduction

Transportation

Over-Processing

Storage

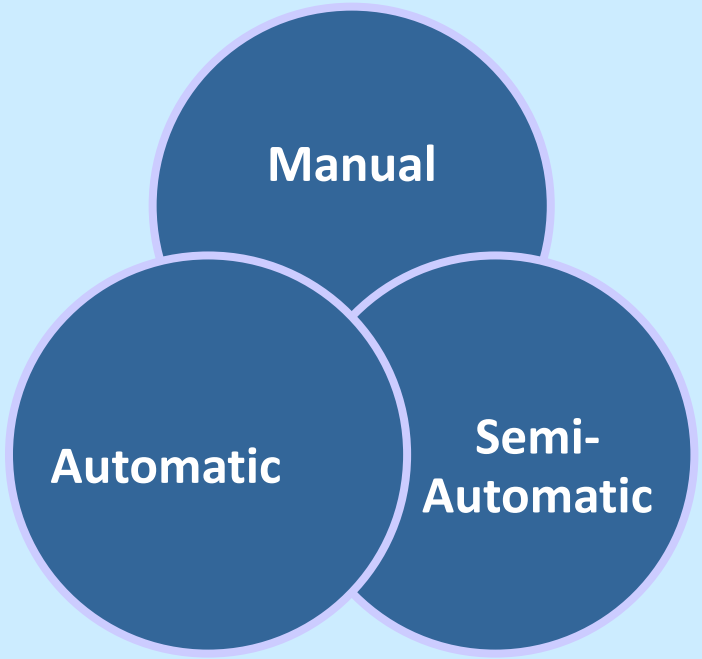
Motion

Quality Defects & Rework

Underutilized Human Capacity

Lost Time (Accidents)

Performing Task (Work)



ENVIRONMENT

Heat/Cold, Noise, Lighting, Vibration, etc

Firmware

Software-Loaded Hardware for Proper Identification

Hardware

Display Control, Machine, Equipment , etc

TASK

Software

Man, Manuals, Information, etc

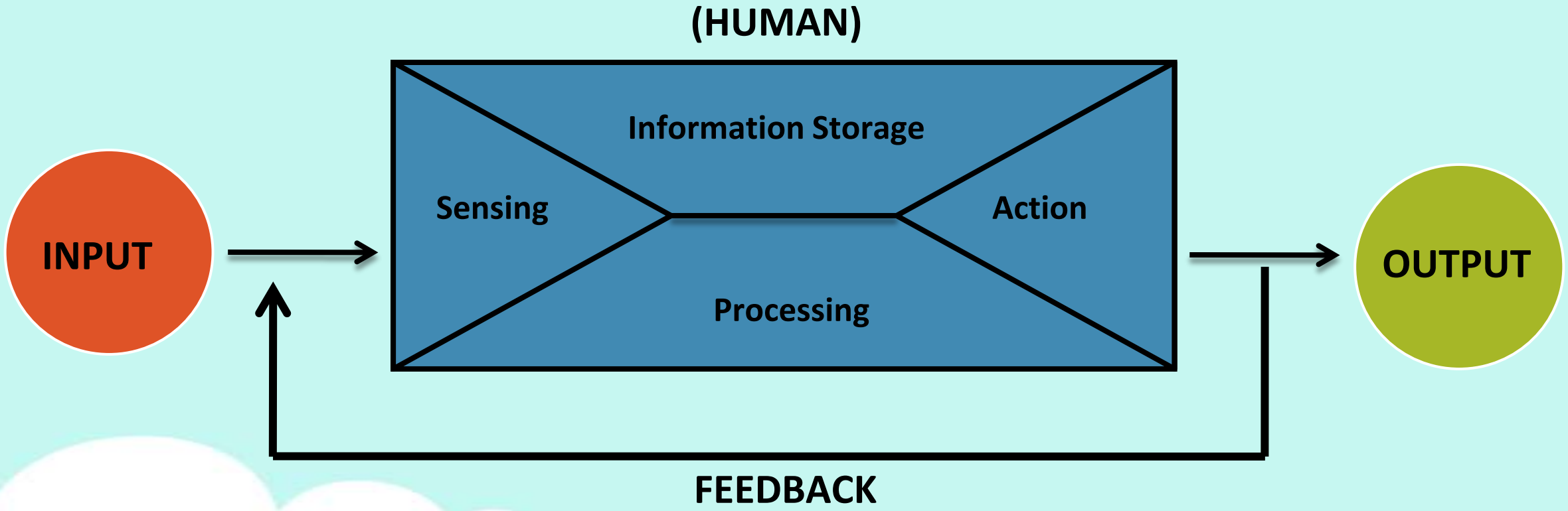
Human Operator

Age, Sex, Education, Experience, etc

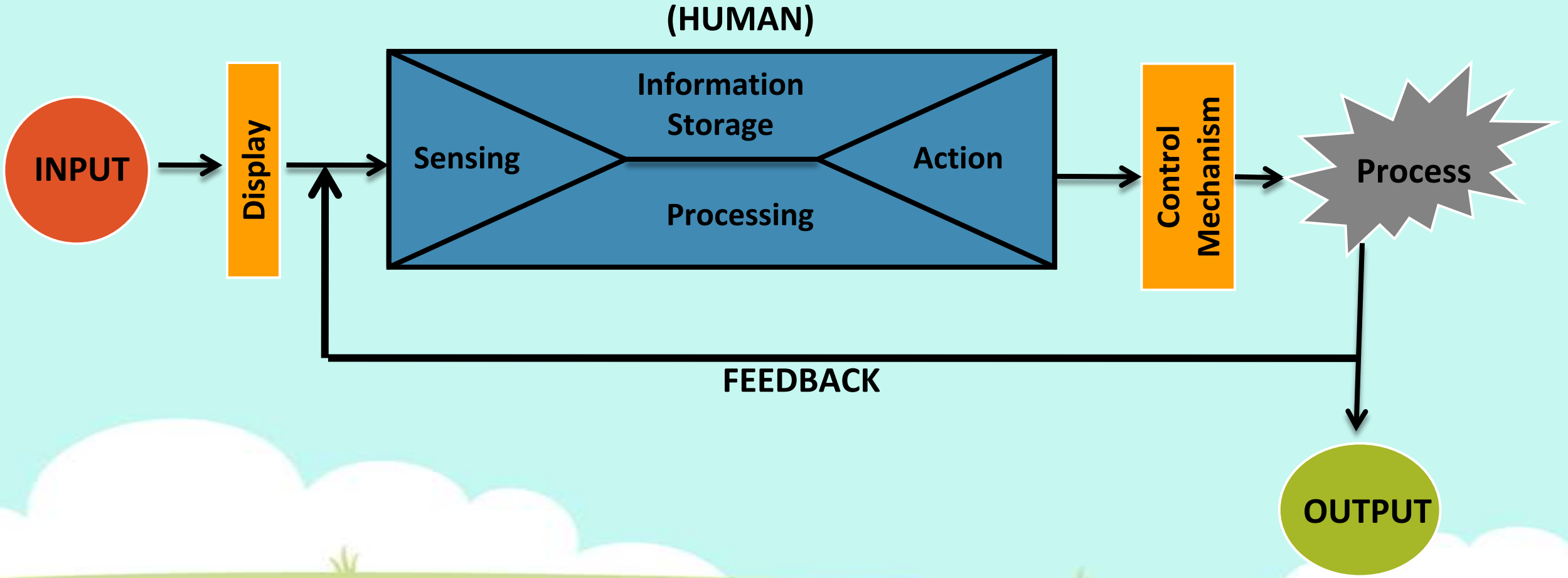
INPUT → OUTPUT

Feedback

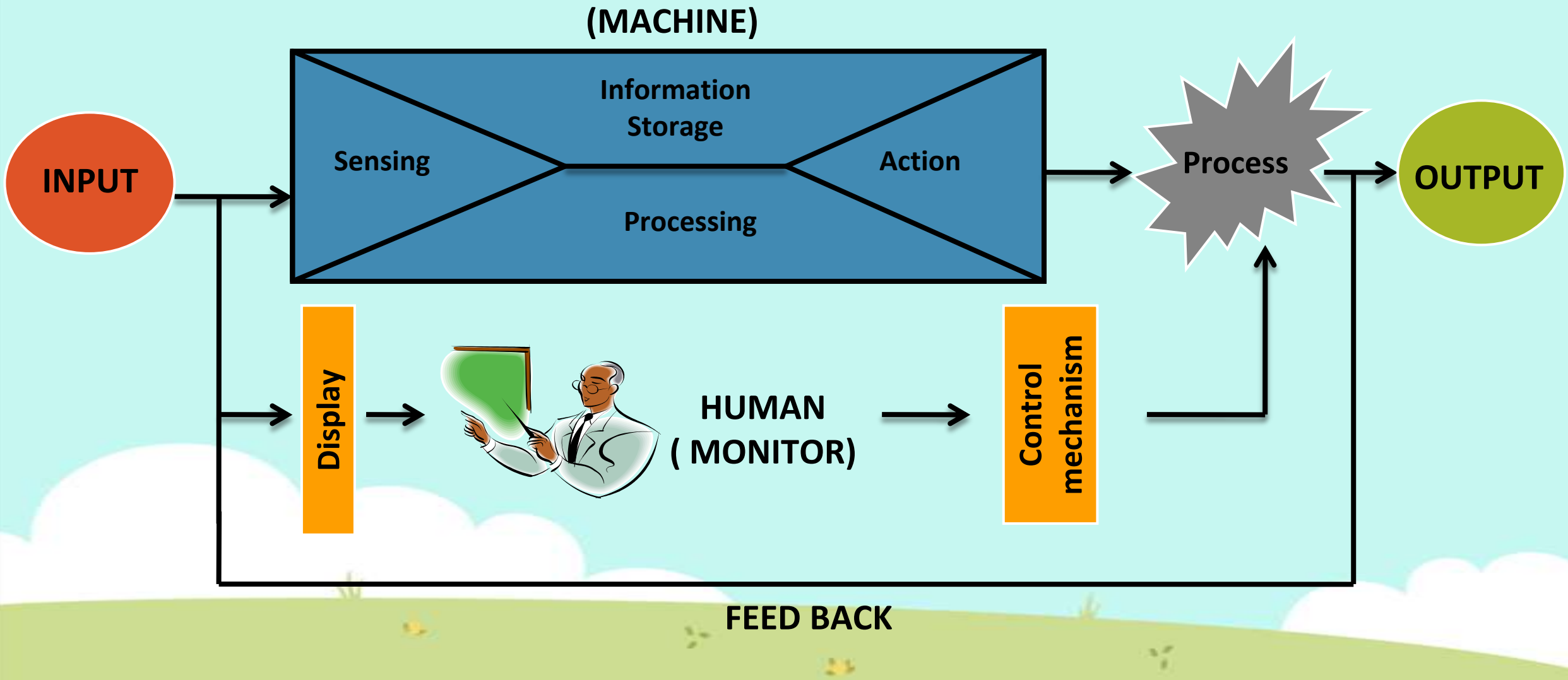
Manual Work


(HUMAN)
Information Storage
Sensing
Action
Processing
INPUT
OUTPUT
FEEDBACK

Semi-Automatic Work



Automatic Work



PRODUCTIVITY

DEFINITION	REFERENCE
Productivity is what man can accomplish with material, capital and technology. Productivity is mainly an issue of personal manner. It is an attitude that we must continuously improve ourselves and the things around us	Japan Productivity Centre, 1958
Productivity ¼ units of output/units of input	Chew, 1988
Productivity is defined as the ratio of what is produced to what is required to produce it. Productivity measures the relationship between output such as goods and services produced, and inputs that include labour, capital, material and other resources	Hill, 1993
Productivity means how much and how well we produce from the resources used. If we produce more or better goods from the same resources, we increase productivity. Or if we produce the same goods from lesser resources, we also increase productivity. By "resources", we mean all human and physical resources, i.e. the people who produce the goods or provide the services, and the assets with which the people can produce the goods or provide the services	Bernolak, 1997
Productivity is the ability to satisfy the market's need for goods and services with a minimum of total resource consumption	Moseng and Rolstada°s, 2001

Efficiency, Effectiveness, And Productivity

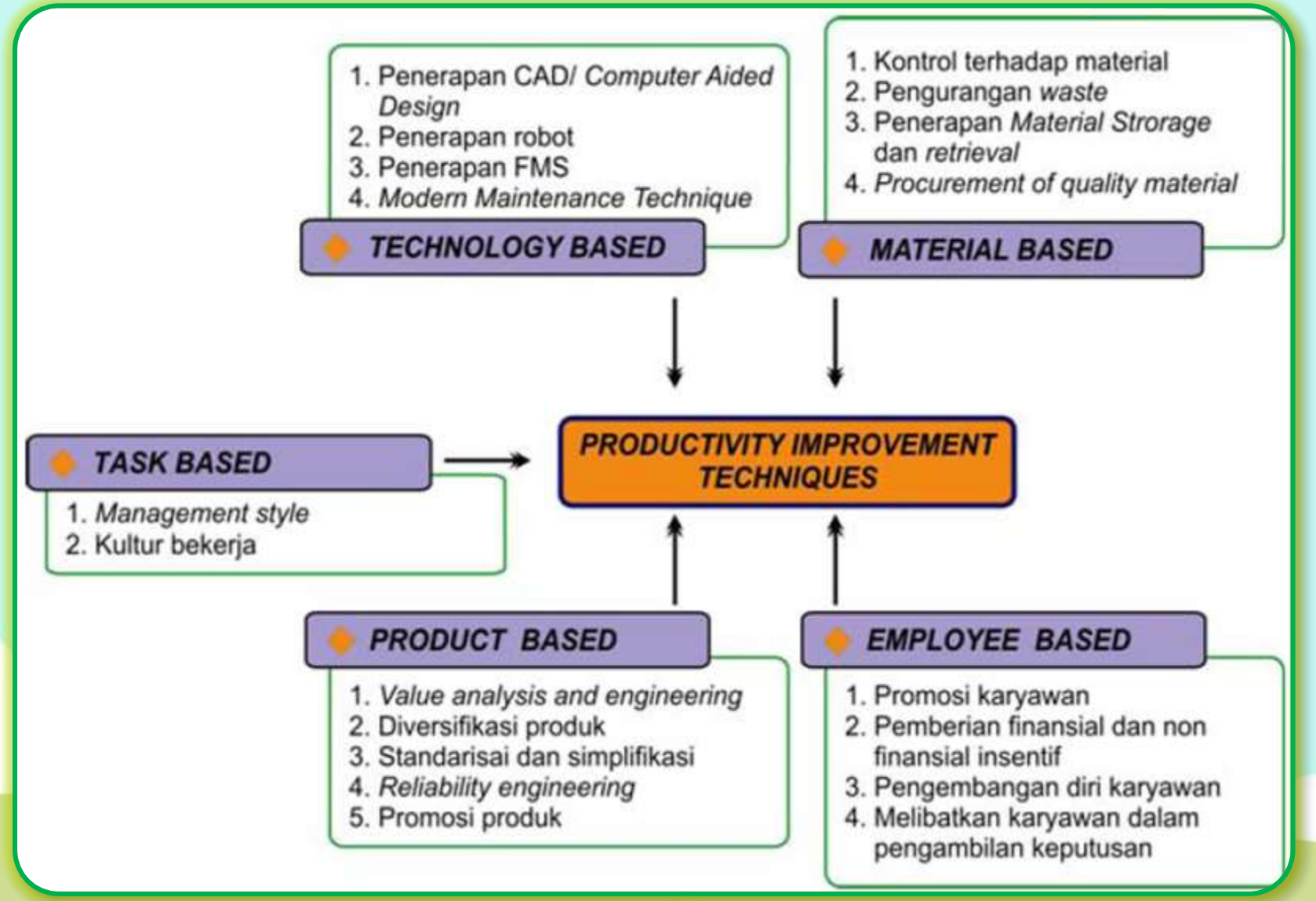
DEFINITION of EFFICIENCY	DEFINITION of EFFECTIVENESS
Efficiency is a measure of how economically the firm's resources are utilised when providing the given level of customer satisfaction	Effectiveness refers to the extent to which the customer requirements are met
do the things right	do the right things

$$produktivitas = \frac{output\ \ yang\ dihasilkan}{input\ yang\ dikeluarkan}$$

$$produktivitas = \frac{hasil\ yang\ sukses\ dicapai}{sumber\ daya\ yang\ dikonsumsi}$$

$$produktivitas = \frac{efektivitas}{efisiensi}$$

Productivity Improvement Strategy



Work Study-Analysis-Design

Methods Study

- To improve methods of production
- Designed to determine the best way to complete a repetitive job

Resulting in more effective use of material, manpower, machine and methods plant and equipment working environments

Work Measurement

- To assess human effectiveness
- Measures how long it takes a worker to complete a task at a normal pace

Making possible improved planning and control manning and as a basis for sound incentives schemes

Higher Productivity

Methods Study

Purposes of Methods Study

- The improvement of processes and procedures.
- The improvement of plan, office or service area layout.
- Economy in human effort and the reduction of unnecessary fatigue.
- Improvement in the use of materials, machines and manpower.
- Development of a better physical working environment

Importance of Methods Study

Changes in tools and equipment.

Changes in product design or new products.

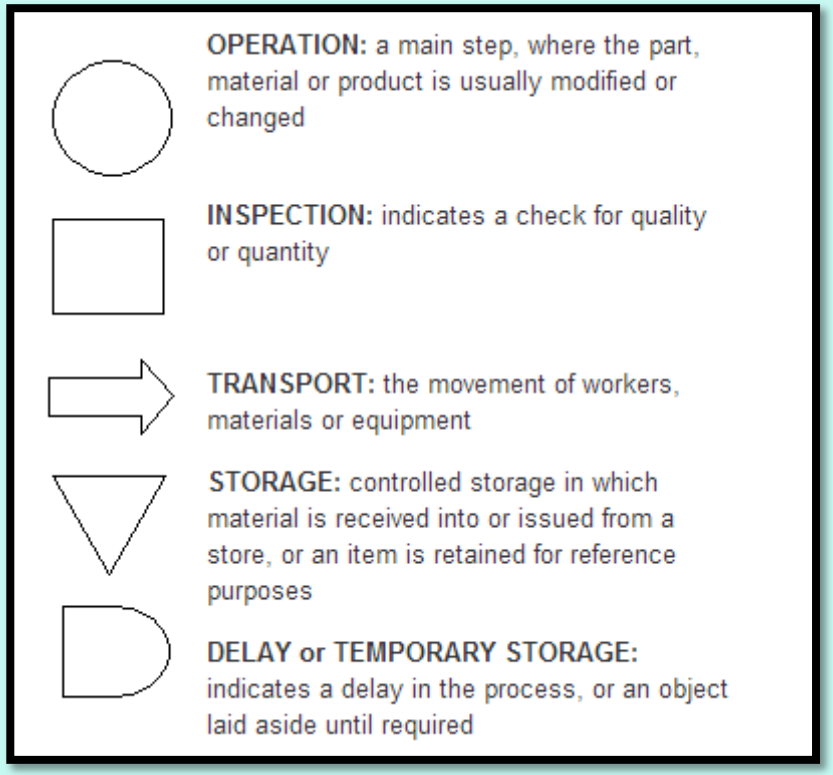
Changes in materials or procedures.

Other factors (e.g. accidents, quality problems).

Document and Analyze Present Method

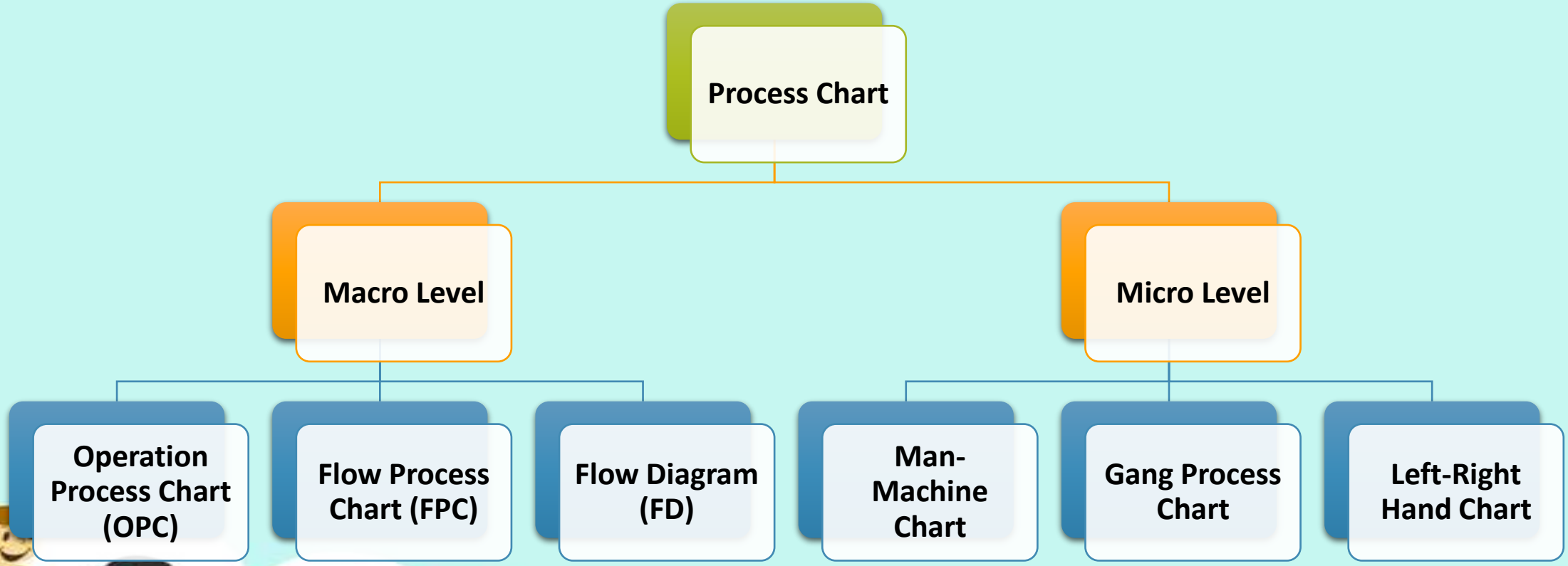
- Obtain production requirements.
- Procure engineering data.
- Procure manufacturing and cost data.
- Description and sketches of work station and tools.
- Use process chart, e.g. assembly chart, flow process chart, flow diagram, worker-machine activity chart, etc.

Process Chart



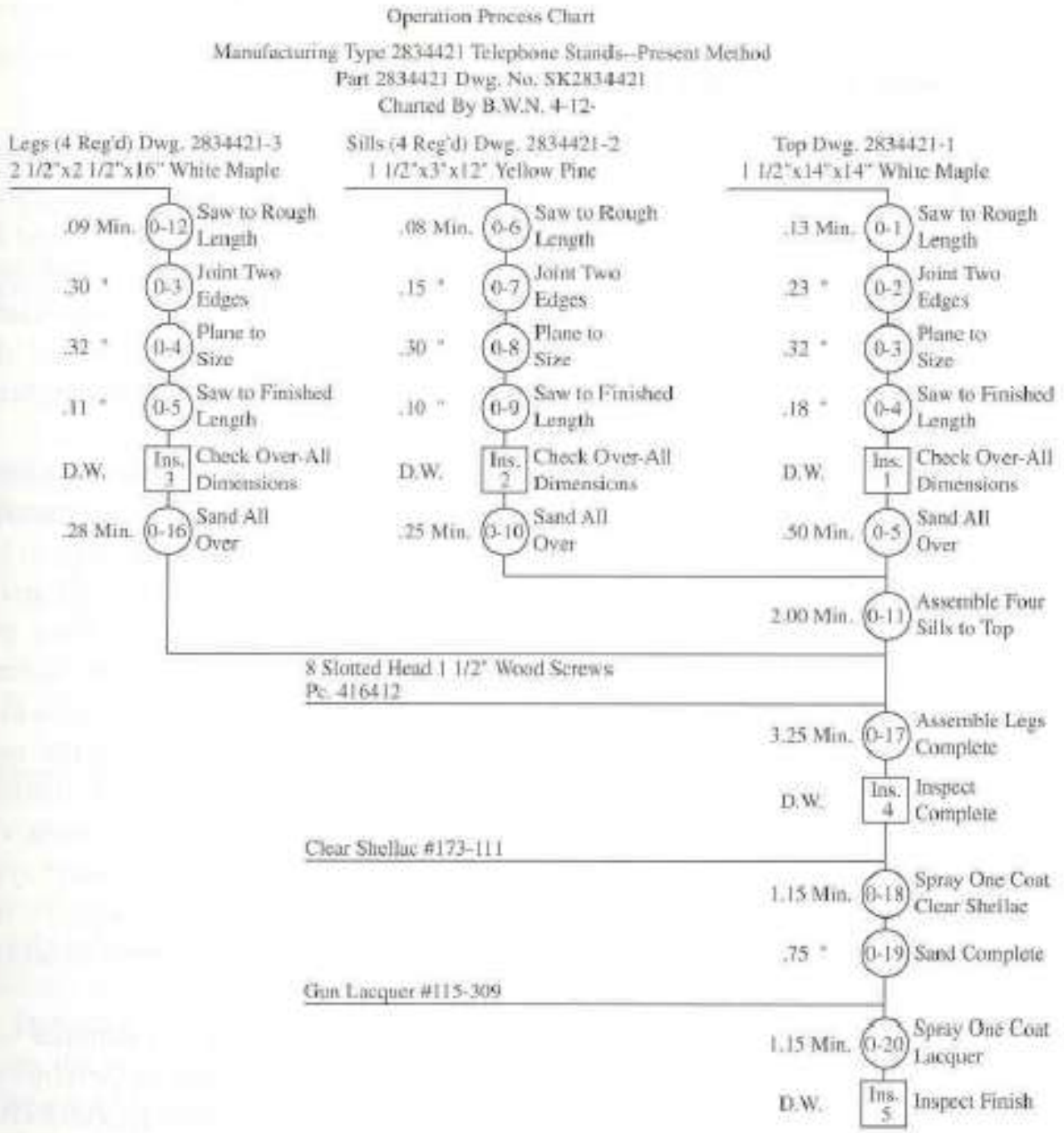
- Process Charts are a form of workflow/ working process/ systems/ procedures charting to record the essential features of a work situation for subsequent analysis.
- The different kinds of process chart share a common core set of symbols (five), were first promulgated by the American Society of Mechanical Engineers (ASME).
- Process charts have been designed to meet the needs of a particular level or stage of analysis :
  - At a detailed level (recording activity at a specific work station or workplace), or MICRO-LEVEL PROCESS CHART.
  - At the wider system, process, or procedure level (MACRO-LEVEL PROCESS CHART)

Classification of Process Chart



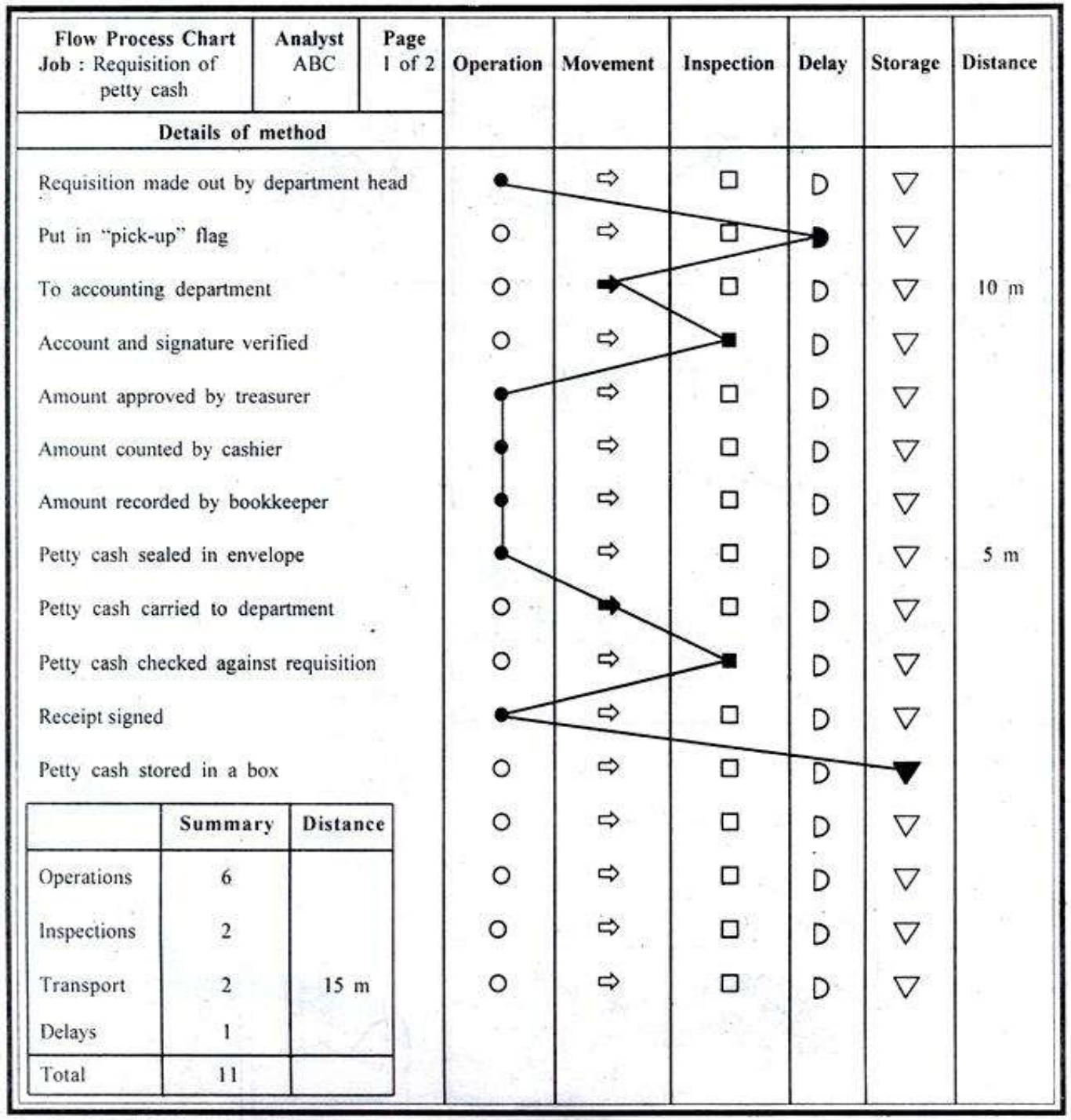
Operation Process Chart (OPC)

- The OPC shows the chronological sequence of all operations, inspections, time allowances, and materials used in a manufacturing or business process, from the arrival of raw material to the packaging of the finished product.
- The OPC depicts the entrance of all components and subassemblies to the main assembly.
- Two symbols are used in constructing the OPC : an operation and an inspection.



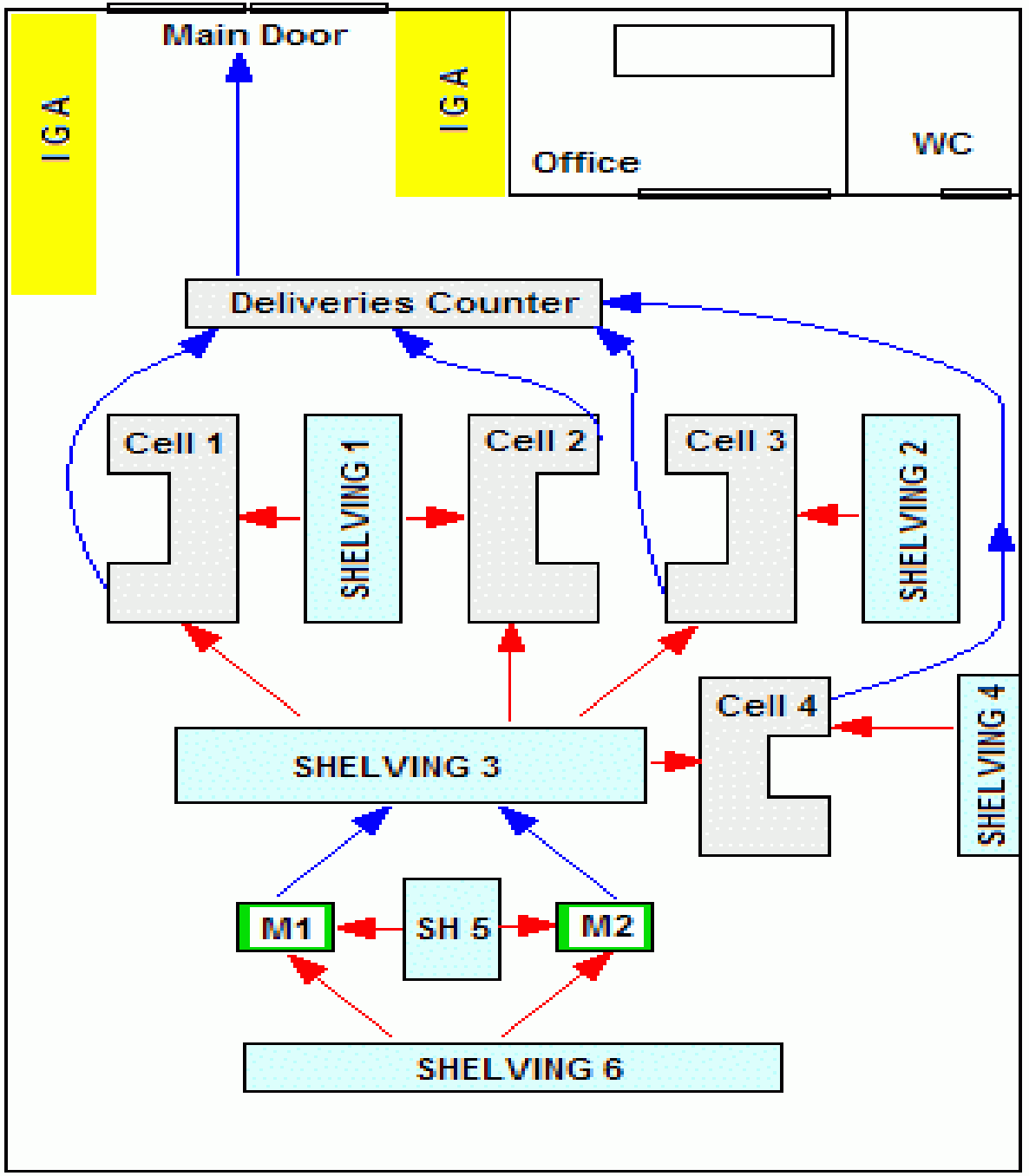
Flow Process Chart (FPC)

- The flow process chart is a device for recording a process in a compact manner, as a means of better understanding it and improving it.
- The chart represents graphically the separate steps or events that occur during the performance of a task or doing a series of actions.
- The chart usually begins with the raw material entering the factory and follows it through every step.
- FPC uses all (five) symbols of ASME.



Flow Diagram (FD)

- A pictorial representation of the layout of floors and buildings, showing the locations of all activities on the flow process chart, is a flow diagram.
- The flow diagram is a helpful supplement to the flow process chart because it indicates backtracking and possible traffic congestion areas, and it facilitates developing an idea plant layout.



MATERIALS FLOW & PRODUCT FLOW

Man-Machine Chart

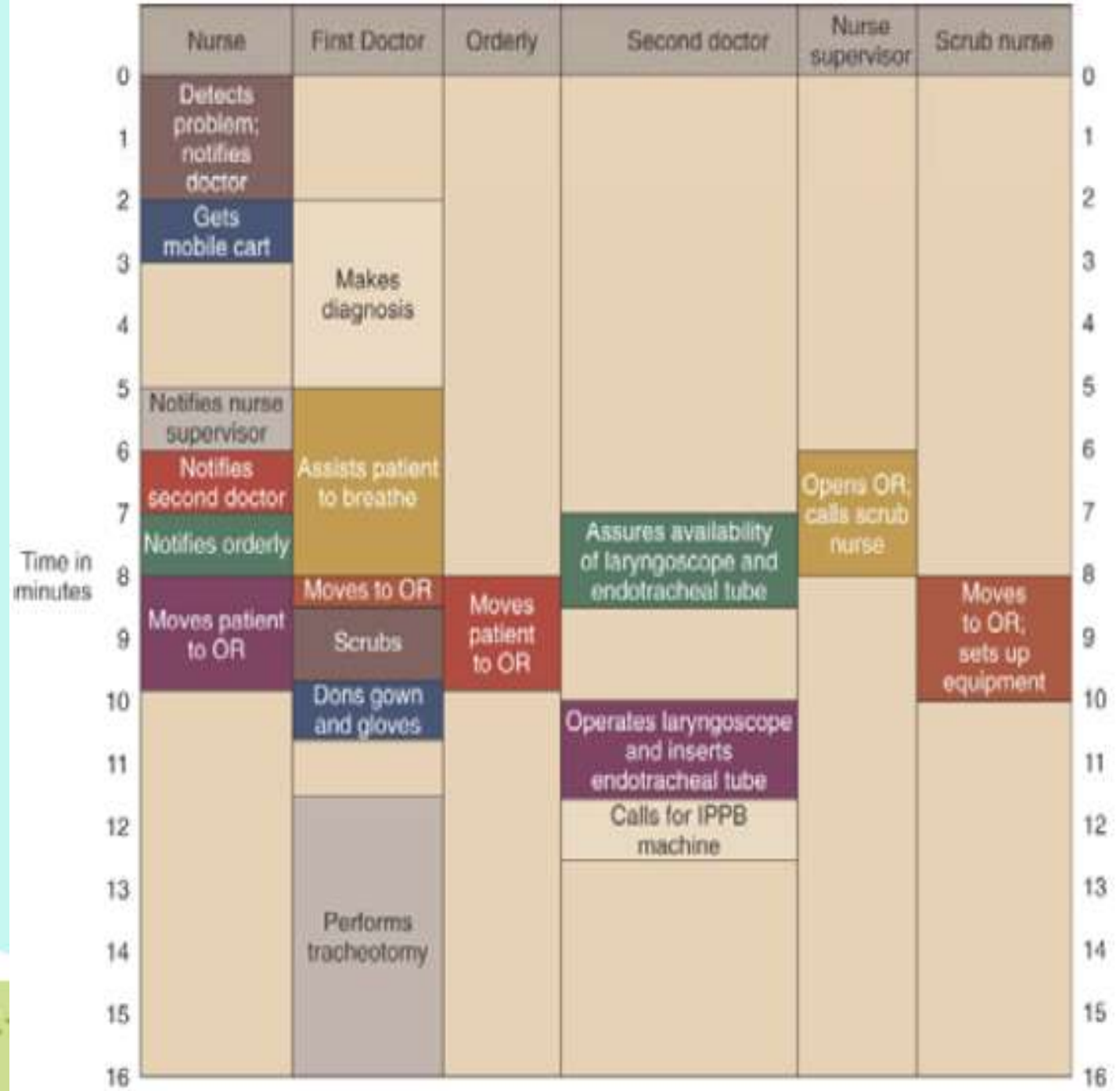
- The Man-Machine Chart is used to study, analyze, and improve one workstation at a time.
- The chart shows the exact time relationship between the working cycle of the person and operating cycle of the machine.
- These facts can lead to utilization of both worker and machine time, and a better balance of the work cycle.
- The utilization of this idle time can increase operator earnings and improve production efficiency.

Summary			
	Customer	Clerk	Coffee grinder
Idle time	48 sec.	21 sec.	49 sec.
Working time	22	49	21
Total cycle time	70	70	70
Utilization in percent	Customer utilization = $\frac{22}{70} \approx 31\%$	Clerk utilization = $\frac{49}{70} = 70\%$	Machine utilization = $\frac{21}{70} = 30\%$

	PERSON				MACHINE	
	Customer	Time in sec.	Clerk	Time in sec.	Coffee Grinder	Time in sec.
0	1. Ask grocer for 1 pound of coffee (brand and grind)	5	Listen to order	5	Idle	5
10	2. Wait	15	Get coffee and put in machine, set grind, and start grinder	15	Idle	15
20	3. Wait	21	Idle while machine grinds	21	Grind coffee	21
40	4. Wait	12	Stop grinder, place coffee in package, and close it	12	Idle	12
50	5. Receive coffee from grocer, pay grocer, and receive change	17	Give coffee to customer, wait for customer to pay for coffee, receive money, and make change	17	Idle	17
60						
70						

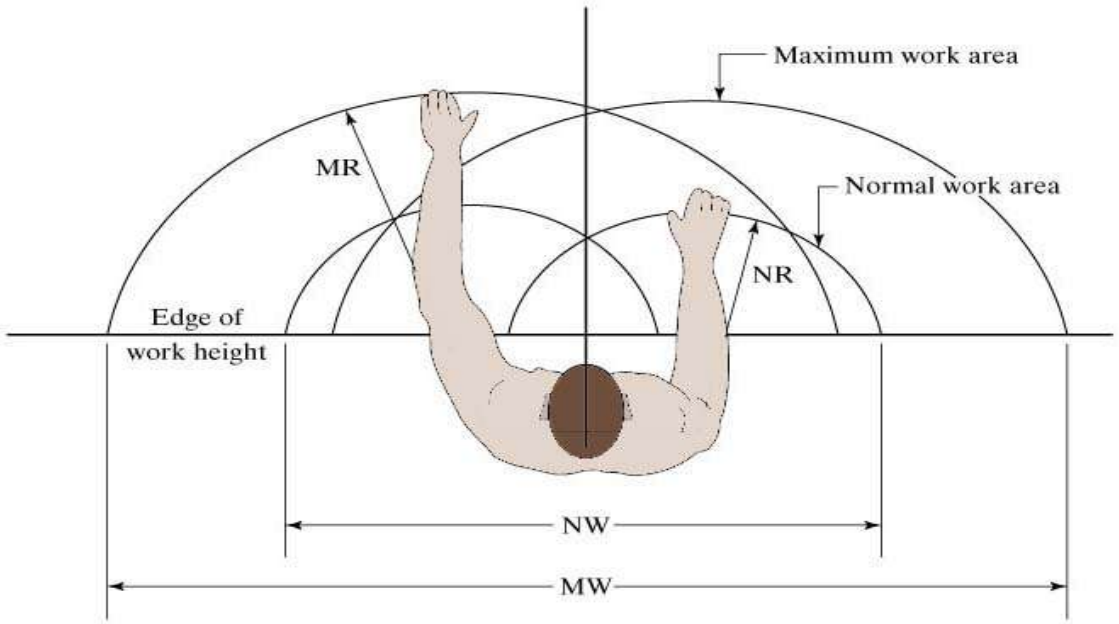
Gang Process Chart

- The Gang Process Chart is an adaptation of the worker and machine process chart.
- The gang process chart shows the exact relationship between the idle and operating cycle of the machine and the idle and operating times per cycle of the workers who service that machine.
- This chart reveals the possibilities for improvement by reducing both idle operator time and idle machine time.



Left-Right Hand Chart

- The Left-Right Hand (Operator) Chart is used to show the activities/motions of operator's hand during work, e.g. repetitive assembly.
- The purpose is to eliminate unnecessary motion, known as motion economy.



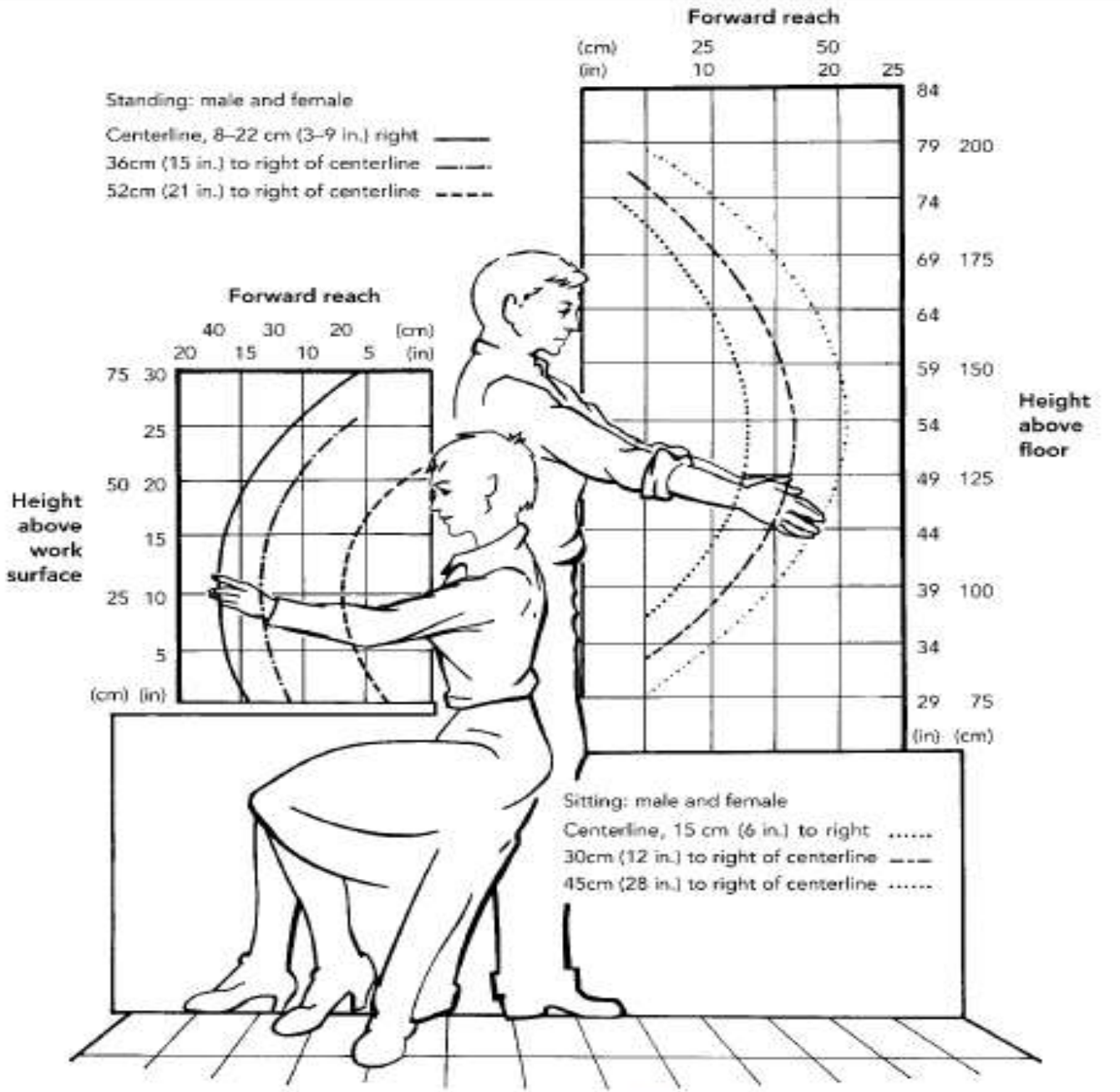


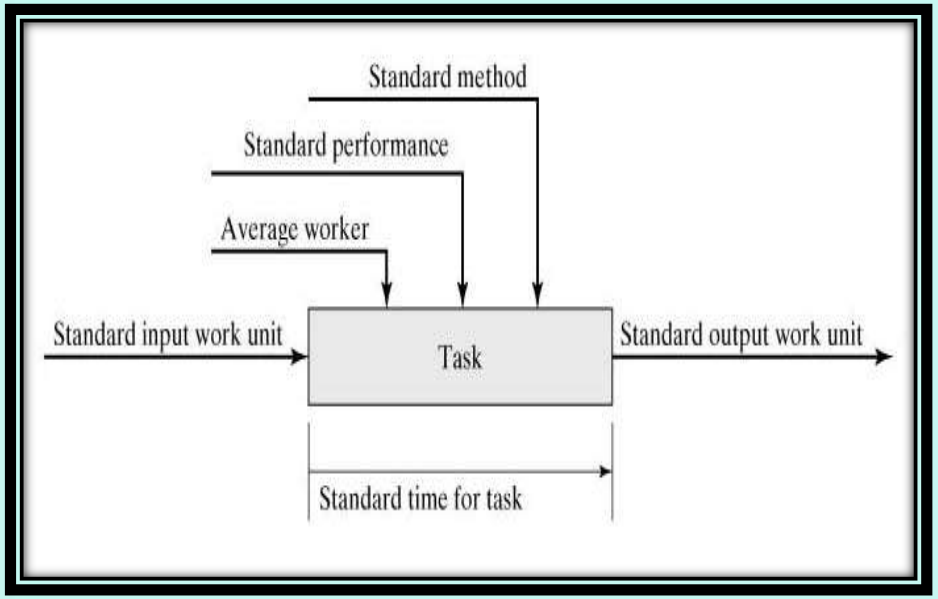
Figure 5 Approximate Reach Distances for Average U.S. Male and Female Workers. (From V. Putz-Anderson, Ed., *Cumulative Trauma Disorders*, copyright © 1988 Taylor & Francis Books Ltd., by permission)

Work (Time) Measurement

Work (Time) Measurement

- Why is time of work?
  - ✓ to determine manpower requirements and capacity limitations.
  - ✓ an objective way to compare alternative methods for accomplishing the same task.
  - ✓ a basis for wage incentives and for evaluating worker performance.
  - ✓ time data for production planning and scheduling, cost estimating, material requirements planning.
- Definition of Work Measurement / Time Study : *techniques that are concerned with the evaluation of a task in terms of the time that should be allowed for an average worker to perform that task*.
- Objective : to determine **a standard time** for the task.

Prerequisites For Valid Time Standards



- The **standard time** for a given task is the amount of time that should be allowed for an average worker to process one unit using the standard method and working at a normal pace.
- As a prerequisite for establishing a standard time for a task, all of these factors must be standardized. The standardized factors are the following:
  - The task is performed by an ***average qualified worker***
  - The worker's pace (speed) represents ***standard performance***
  - The worker uses the ***standard method***
  - The task is performed on a ***standard output unit*** that is defined before and after processing.

When Are Time Standards Beneficial?

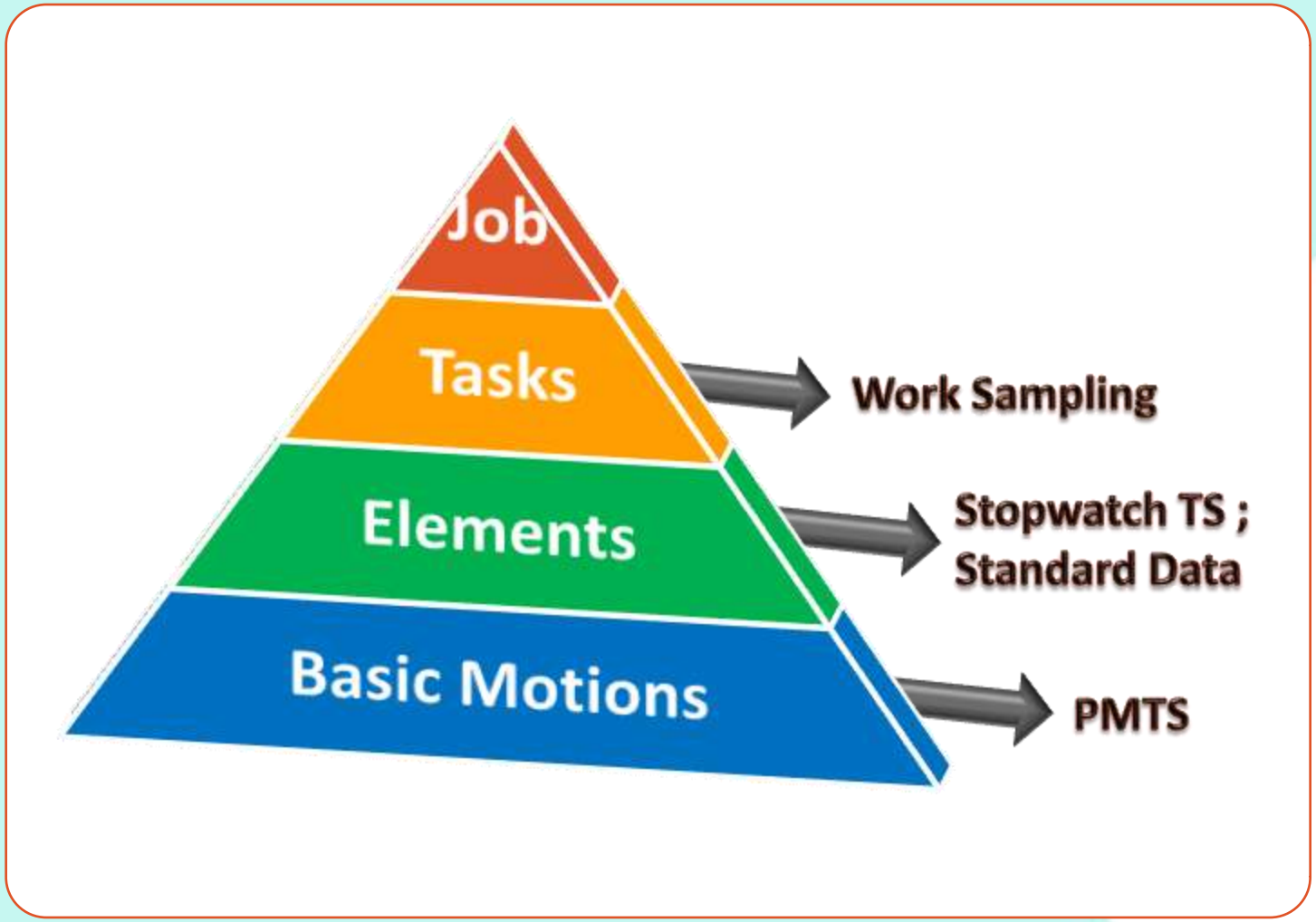
How does an organization know whether it needs time standards for its operations?

The following characteristics are typical of industrial situations in which time standards would be beneficial:

- **Low productivity**. If the current level of productivity is low.
- **Repeat orders**. Once the time standard is set during the first order, the same standard can be used for successive orders.
- **Long production runs**. Means that the time invested to set the standard is assigned over more parts.
- **Repetitive work cycles**. When the work cycle is highly repetitive.
- **Short cycle times**. Short work cycles require less time to set standards.

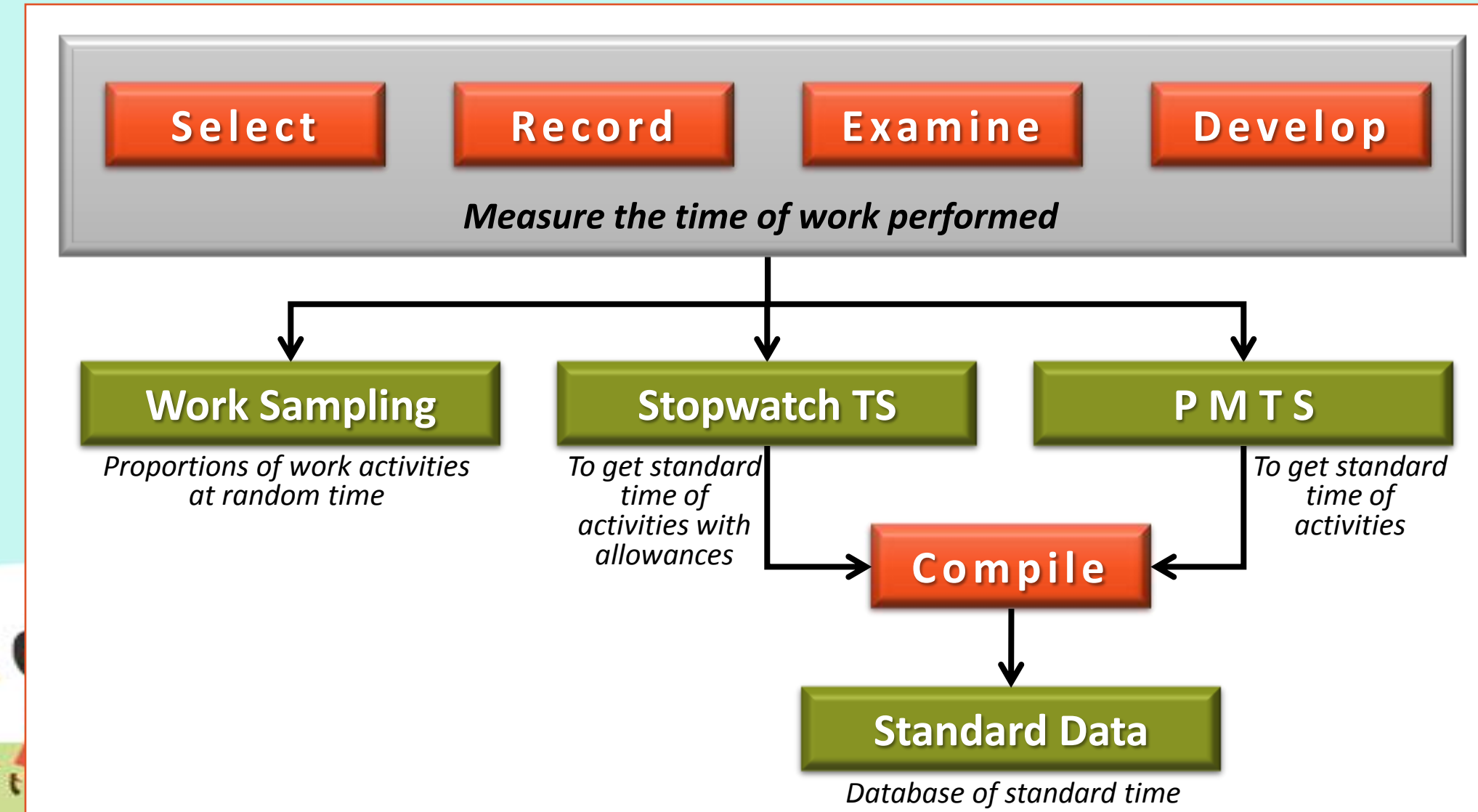
Methods to Determine Time Standards

- **Estimation**
  - The department foreman or other person familiar with the jobs performed in the department is asked to judge how much time should be allowed for the given task.
- **Historical records of previous production runs**
  - In this method, the actual times and production quantities from records of previous identical or similar job orders are used to determine the time standards.
- **Work Measurement (WM) techniques**
  - The work measurement techniques are more time consuming to implement but they are more accurate than estimation or historical records.
  - Direct WM : Stopwatch (Direct) Time Study, Work Sampling
  - Indirect WM : Predetermined Motion Time Systems (PMTS), Standard Data System.

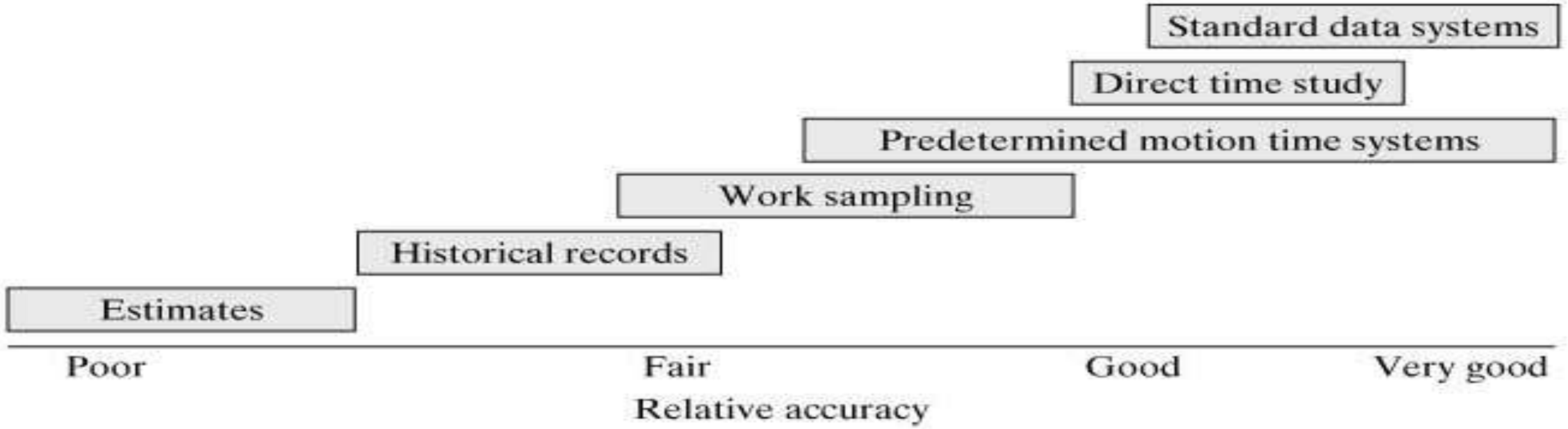


The Pyramidal Structure of Work & WM Techniques

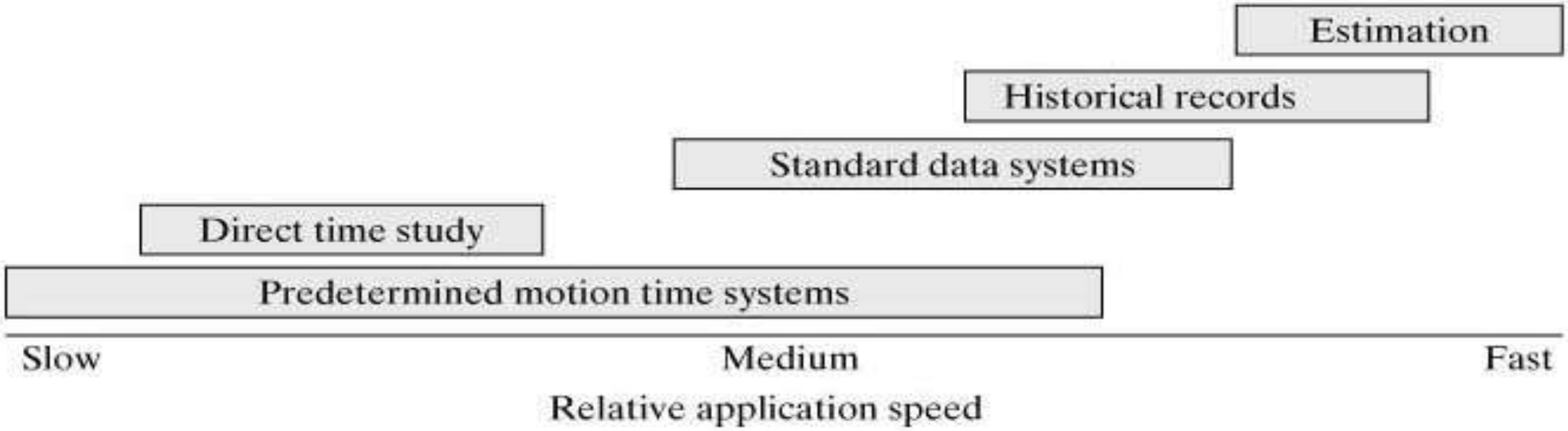
Work Measurement Techniques



ACCURACY



SPEED



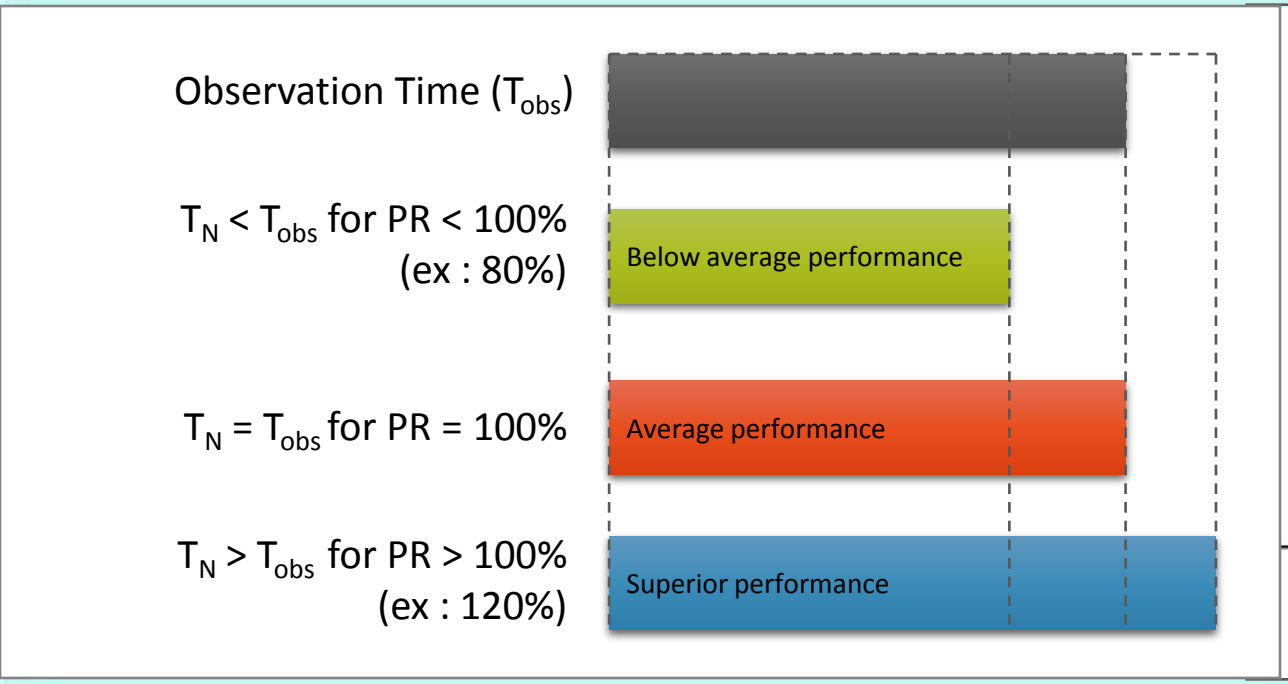
Work Measurement Techniques

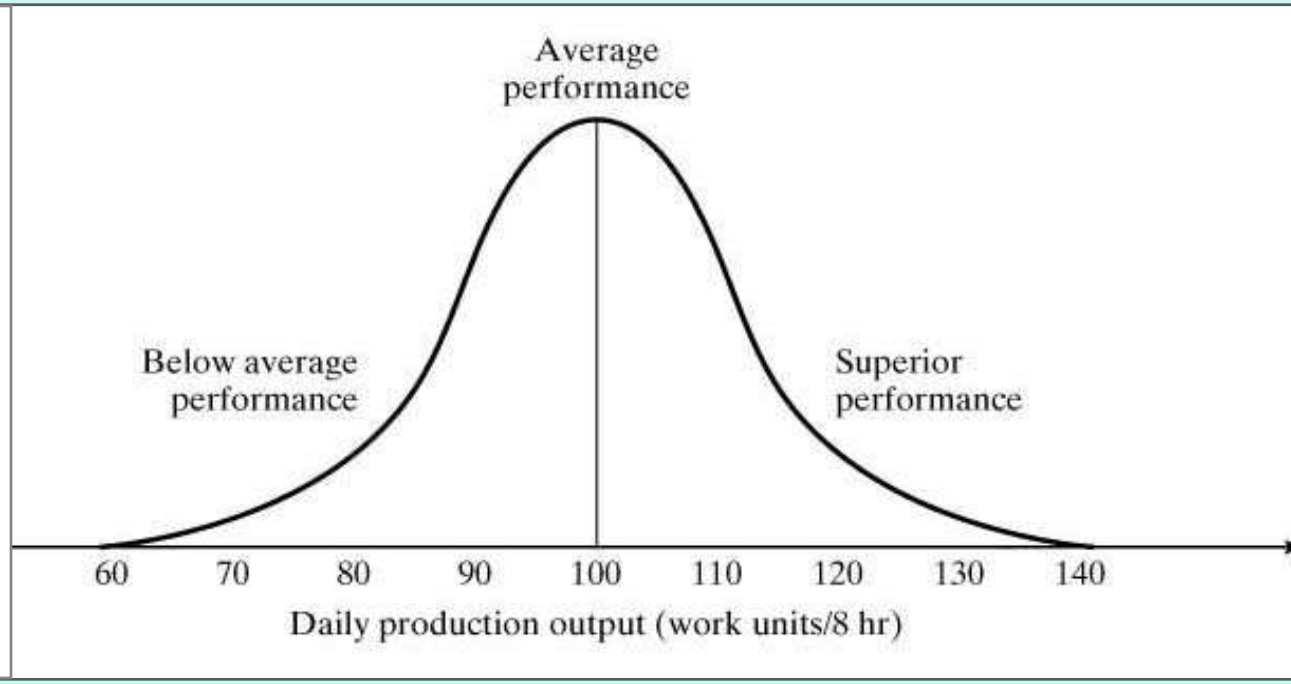
- **Work Sampling (WS)** : determine proportions of time spent in various categories of work activity using randomized observations of the subjects of interest.
- **Stopwatch Time Study (STS)** : direct observation of a task using a stopwatch or other chronometric device to record the time taken to accomplish the task. The task is usually divided into work elements and each work element is timed separately.
- **Predetermined Motion Time System (PMTS)** : set a standard time for a given task, lists all of the basic motions that comprise the task, and recovers the normal time for each element from the basic motion table.
- **Standard Data System** : a compilation of normal time values for work elements used in tasks that are performed in a given facility. The normal time values in a standard data system are usually compiled from previous direct time studies, such as PMTS, STS, WS, or even historical time records.

General Steps to Determine Standard Time

1. Record all task-related information
2. Divide task into elements
3. Observe, measure, and record time of each elements (10 replications) → **Observation Time**
4. Record the performance rating and allowance for each operator observed (only for STS & WS)
5. Evaluate data recorded, such as normality, uniformity, adequacy
6. Calculate the **Normal Time** (affected by **performance rating**).
7. Calculate the **Standard Time** (affected by **allowances**)

Performance rating (PR) & Normal Time





Normal Time :
$T_N = T_{obs}$ (PR)

If worker performance is expressed in terms of daily output, thus for an output of 100 pieces per day (480 min) at average performance by qualified worker.

An average qualified worker is one who has acquired the skill, knowledge and other attributes to carry out the work in hand to satisfactory standards of quantity, quality and safety.

Westinghouse Rating System

Skill		Effort	
+ 0.15 A_1 - Superskill	- 0.05 E_1 - Fair	+ 0.13 A_1 - Excessive	- 0.04 E_1 - Fair
+0.13 A_2	- 0.10 E_2	+ 0.12 A_2	- 0.08 E_2
+0.11 B_1 - Excellent	- 0.16 F_1 - Poor	+ 0.10 B_1 - Excellent	- 0.12 F_1 - Poor
+0.08 B_2	- 0.22 F_2	+ 0.08 B_2	- 0.17 F_2
+0.06 C_1 - Good		+ 0.05 C_1 - Good	
+0.03 C_2		+ 0.02 C_2	
0.00 D - Average		0.00 D - Average	

Conditions		Consistency	
+ 0.06	A - Ideal	+ 0.04	A - Perfect
+ 0.04	B - Excellent	+ 0.03	B - Excellent
+ 0.02	C - Good	+ 0.01	C - Good
0.00	D - Average	0.00	D - Average
- 0.03	E - Fair	- 0.02	E - Fair
- 0.07	F - Poor	- 0.04	F - Poor

Allowances in Time Standards

- **Allowances** are used because there will be periods during the regular work shift when the worker is not working.
- The purpose of the allowance factor is to compensate for this lost time by providing a small increment of "allowance time" in each cycle. This way, even with the time losses, the operator will still be able to complete a day's work during the hours of the shift.
- Normal time is adjusted by an $\mathbf{A_{pfd}}$ (allowance for personal time, fatigue, delay) to obtain the standard time

Standard Time :

$$T_{STD} = T_N (1 + A_{pfd})$$

Standard Output :

$$O_{STD} = 1 / T_{STD}$$

PROBLEM # 1

The average observed time for a repetitive work cycle in a direct time study was 3.27 min. The worker's performance was rated by the analyst at 90%. The company uses a PFD allowance factor of 13%. What is the standard time for this task?

Solution # 1

Normal time : $T_N = 3.27\ (0.90) = 2.943$ min

Standard time : $T_{STD} = 2.943\ (1 + 0.13) = 3.326$ min

PROBLEM # 2

The ABC Company uses a standard data system to set time standards. One of the time study analysts listed the three work elements for a new task to be performed in the shop and then determined the normal time values to be 0.73 min, 2.56 min, and 1.01 min. The company uses a PFD allowance factor of 16%. Determine the standard time for the task.

Solution # 2

Normal time : $T_N = 0.73 + 2.56 + 1.01 = 4.30$ min;

Standard time : $T_{STD} = 4.30\ (1 + 0.16) = 4.988$ min

PROBLEM # 3

Determine the personal time, fatigue, and delay (PFD) allowance to be used for computing time standards in the following situation. Second shift workers punch in at 3:30 p.m. and punch out at 12:00 midnight. They are provided one-half hour for supper at 6:00 p.m., which is not counted as part of the 8-hour shift. For purposes of determining the allowance, 30 minutes of break time (personal time and fatigue) are allowed each worker. In addition, the plant allows 35 min for lost time due to unavoidable delays. What should the PFD allowance factor be?

Solution # 3

Allowance time for 30 min of break time plus 35 min for lost time = 65 min

Allowance factor A_{pfd} = 480/(480 - 65) – 1 = 1.157 – 1 = 0.157

= 15.7%


systems
Industrial
Engineers
Engineering
Business
processes
operations
control
design
planning
knowledge
engineering
production
manufacturing
analyze
scheduling
program
system
quality
allows
individual
complex
Offered
pursue
skills
large
college


KEEP
CALM
YOU'RE AN
INDUSTRIAL
ENGINEER