



## Introduction to Work Measurement

---

Sections:

1. Time Standards and How They Are Determined
2. Prerequisites for Valid Time Standards
3. Allowances in Time Standards

### Chapter 12

1



## Some Definitions

---

- **Work measurement** – evaluation of a task in terms of the time that should be allowed by an average worker to perform the task
  - **4 techniques**
  - **Focus on human work**

2



## Some Definitions

---

- **Standard time** (allowed time) – amount of time that should be allowed for an average worker to process one work unit using the standard method and working at normal pace
  - It includes some additional time is called **allowance** to provides for the workers:
    - To provides for the workers *personal needs*
    - To reduce *fatigue*
    - Unavoidable delay during the shift

۳



## Some Definitions

---

- **Time study** – all the ways in which time is analyzed in work situations
- How much time it should take to accomplish a given task
- Both terms (work measurement and time study) can be used interchangeably

۴



## When Are Time Standards Beneficial?

---

- Characteristics of industrial situations in which time standards would be beneficial:
  1. **Low productivity**: significant opportunities for improvement
  2. **Repeat orders**: once the time standard is set for the first, it can be used for successive ones
  3. **Long production runs**: reduced average cost of work measurement
  4. **Repetitive work cycles**: work measurement can be justified more readily
  5. **Short cycle times**: requires less time to set standards

o



## Functions of Time Standards

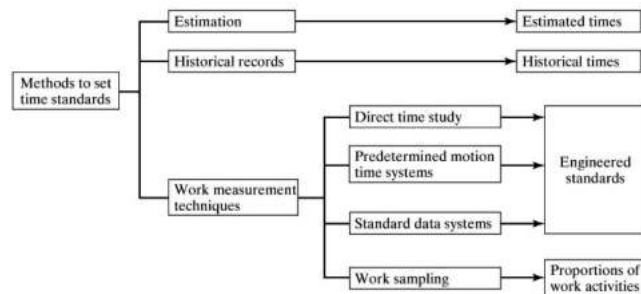
---

- They provide a means to convert workload into staffing and equipment needs
- They allow alternative methods to be compared objectively
- They provide a basis for wage incentives and evaluation of worker performance
- They provide time data for:
  - Production planning and scheduling
  - Cost estimating
  - Material requirements planning

6



## Methods to Determine Time Standards



- Vary in terms of
  - accuracy and reliability of the values derived from the method
  - amount of time required to apply the corresponding method

Y



## Methods to Determine Time Standards

### ▪ Estimation

- Judgment of a person who is familiar with the job
  - Subjective
  - Least accurate method

### ▪ Historical records

- Records on the actual times and production quantities for previous identical or similar job orders - "Time card"
  - Average time per part
  - Improvement over estimates
  - Limitation: No indication of efficiency measures

### ▪ Work measurement techniques

- Time consuming
- More accurate than estimation and historical records

Λ

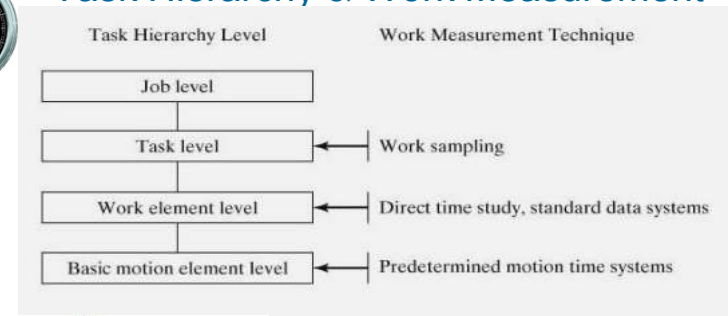


## Work Measurement Techniques

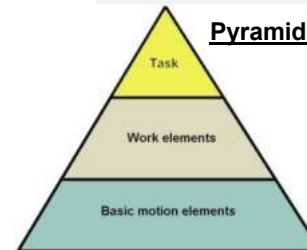
1. Direct time study (DTS)
2. Predetermined motion time system (PMTS)
3. Standard data systems (SDS)
4. Work sampling



## Task Hierarchy & Work Measurement



### Pyramidal Structure of Work



Work measurement techniques measure work at different levels of this hierarchy



## 1. Direct Time Study

- Direct observation of a task using a **stopwatch** to record the time taken to accomplish a task.
- The task is usually divided into **work elements** and each work element is timed separately.
- During the observation, the analyst evaluates the worker's pace - **performance rating**

- Normal time**

$$T_n = T_{obs}(PR)$$

where

$T_n$  = normal time, min;

$T_{obs}$  = observed time, min;

$PR$  = performance rating of the worker's pace

- Standard time**

$$T_{std} = T_n(1 + A_{ptd})$$

$A_{ptd}$  = allowance factor for personal time, fatigue and delay

11



## 2. Predetermined Motion Time Systems

- A database of normal times of **basic motion elements** (therbligs) such as reach, grasp, move etc.
- Conditions under which the motion elements (work variables) are performed **are important**.
- Example:** normal time for **object reach**
  - Distance moved
  - Weight of the object being moved
- The analyst list all of the basic motion elements that comprise the task; then **normal times for basic motion elements are summed up** to obtain the normal time for the task



- Advantages:**

- No need for performance rating
- Can be applied before production starts

12



### 3. Standard Data Systems

---

- A compilation of normal time values for work elements used in the **tasks** performed in facility
- Used to establish time standards for tasks composed of work elements similar to those in the database
- **Source of data:** direct time study, PMTS, work sampling, historical data
- Effect of work variables should be included
  - Tables
  - Charts
  - Mathematical equations

۱۳



### 4. Work Sampling

---

- A random sampling technique to estimate the proportions of time spent in different activities
- Identify activities clearly.
  - **Example:** machine setup, production, idleness
- Multiple subjects (entities) can be included
- Observations
  - **Random:** minimize bias
  - **Large in number:** to achieve statistical accuracy
- Objectives:
  - Setting time standards
  - Estimating resource utilization
  - Determining an allowance factors

۱۴



## Computerized Work Measurement (work study methods)

- Facilitates collection of data
- Performs routine computations
- Organizes time standards files and databases
- Retrieves data in predetermined motion time systems and standard data systems
- Assists in the preparation of the documentation
  - Methods descriptions
  - Reports



10

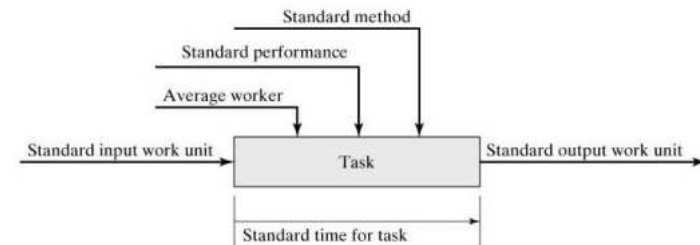


## Prerequisites for Valid Time Standards

Time to perform a task depends on various factors:

- Worker (gender, strength, physical capability and mental abilities etc.),
- Worker's pace (speed, skill, experience),
- Method used (hand tools, equipment, hand & body motion, work environment)
- Work unit (nature of work or task)

Factors that must be standardized before a time standard can be set  
(except for the worker)



11



## Average Worker & Standard Performance

---

### ▪ **Average worker**

- is a persons who usually perform tasks similar to the task being measured.
  - **Gender** factor, if the work is performed mostly by men ( not women), then the average worker is male ( not female)
  - **Age** factor
- Have learned the task (**experience and skill**), **practiced** and **proficient** at it
- Is capable of performing the task **consistently throughout the shift** with **safety condition** and without **fatigue**

17



## Standard (Normal) Performance

---

- **Standard Performance** is a pace (quantity & quality) of working that can be maintained by an average worker throughout an entire work shift without harmful effects on the worker's health or physical well-being.
- **Normal performance** refers to 100% pace while the worker is working without include the breaks period or any delay.
- **Standard performance** refers to 100% pace with the *breaks period and any other delay during the shift.*

18



## Normal time / Standard time

- **Normal time:** Time it takes to perform a task under the normal (standard) (100%) performance
- Normal time is also called: Normalized time OR basic time
- Normal time does not include allowances for time losses (breaks or delay)
- Standard time **minus** allowances time = **Normal time**
- **Standard time:** Normal time + allowance  
Normal time  $(1 + A_{pfd})$

$$T_{std} = T_n(1 + A_{pfd})$$

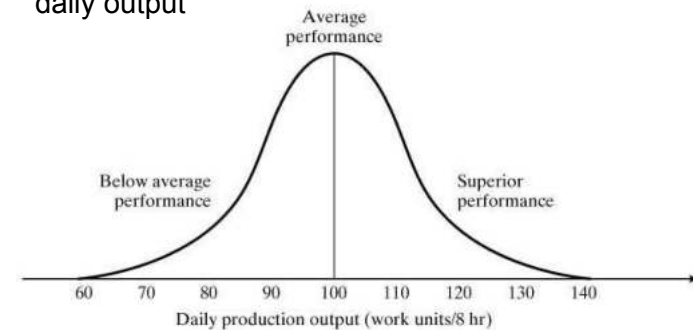
۱۹



## Distribution of Worker Performance

Variations among workers → performance variations

Worker performance is expressed in terms of daily output



۲۰



## More on Standard Performance

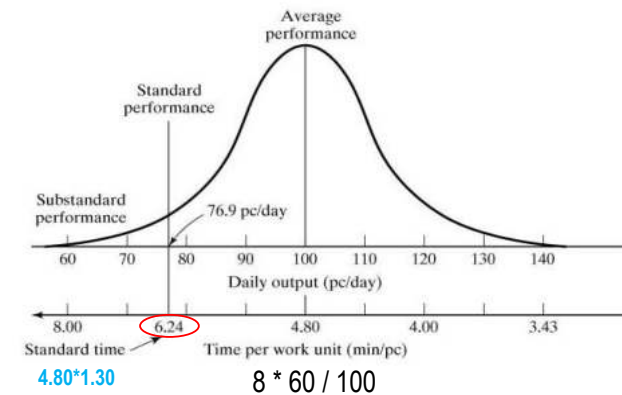
- Standard performance is commonly defined to be a pace that can be readily attained by the majority of workers
- Companies want most workers to be able to achieve the standard performance easily.
  - A typical policy is to define standard performance so that an average worker is able to work at a pace that is **130%** of that pace
    - Thus, most workers are able to easily achieve standard performance

٢١



## How a Standard Time is Defined

Distribution of worker performance, indicating how standard time is defined so that it can be readily achieved by most workers



٢٢



## Standard Method

- Determining the optimum method for processing a work unit
- “One best method”: the safest, quickest, most productive, and least stressful to the worker
- Must include all of the details on how the task is performed, including:
  - Procedure - hand and body motions
  - Tools (hand tools, power tools, fixtures and gauges)
  - Equipment
  - Workplace layout (what are the locations of the parts, tools)
  - Irregular work
  - Working conditions (is the work performed outside or inside)
  - Setup (what setup of physical tools & equipment are required)

۲۳



## Allowances in Time Standards

- Normal time is adjusted by an allowance factor  $A_{pfd}$  to obtain the **standard time**
- Purpose of allowance factor ( $A_{pfd}$ ) is to compensate for lost time due to work interruptions and other reasons during the shift.
- **Standard time:**

$$T_{std} = T_n(1 + A_{pfd})$$

where **pfd** = personal time, fatigue, and delays

۲۴



## Example: Standard time

### ▪ **Problem # 12.3 (page 340)**

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:**

$$T_{std} = T_n(1 + A_{pfd})$$

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

٢٥



## Reasons for Lost Time at Work

### Work-related interruptions

- Machine breakdowns
- Waiting for materials or parts
- Receiving instructions from foreman
- Talking to co-workers about work-related matters
- Rest breaks for fatigue
- Cleaning up at end of shift

### Non-work-related interruptions

- Personal needs (e.g., restroom breaks)
- Talking to co-workers about matters unrelated to work
- Lunch break (not included in  $A_{pfd}$ )
- Smoke break
- Drink break
- Personal telephone call

٢٦



## How to Allow for Lost Time

- Two approaches used by companies:
  1. Scheduled rest breaks during the shift
    - Typical - one 15-minute break in mid-morning and another in mid-afternoon
  2. A PFD allowance factor is added to the **normal time**
    - This allows the worker to take a break on his/her own time
    - PFD is called [Relaxation Allowances](#) represent in % **value**
    - Relaxation allowance OR PFD are calculated to [allow the worker to recover from fatigue](#)

٢٧



## PFD Allowance (Cont.)

- **Personal time**
  - Rest room breaks, phone calls, water fountain stops, cigarette breaks (5% typical)
  - **For example:** A larger value will be appropriate if the work environment is hot
- **Fatigue** (Physical fatigue OR Mental fatigue)
  - Rest allowance to overcome fatigue due to work-related low or medium stresses and conditions (5% or more)
  - **For example:** If the work is physiologically very demanding (heavy workload), then relaxation time should be allowed periodically for the body to recover (*in this case use 20% allowance*)
- **Delays**
  - **Random, unavoidable interruptions**
  - Machine breakdowns, foreman instructions (5% typical)
  - Usually management is responsible for these delays.

٢٨



## Example: PFD Allowance factor

### ▪ Problem # 12.5 (page 341)

In the WS&FP plant, workers punch in at 8:00 a.m. and punch out at 5:00 p.m. The labor-management agreement allows one hour for lunch, which is not counted as part of the 8-hour shift. In determining the allowance for computing time standards, two 12 min breaks are included (personal time and fatigue), one in the morning and one in the afternoon; and 35 min are included as lost time due to interruptions and delays. What PFD allowance factor should be added to the normalized time to account for these losses in the computation of a standard time, so that if the worker works at standard performance, he/she will earn exactly eight standard hours?

۲۹



## Example: PFD Allowance factor

### ▪ Solution

$$T_{std} = T_n(1 + A_{pfd})$$

- Allowance time for two 12-min breaks plus 35 min for lost time = **59 min**

$$\text{Allowance factor } A_{pfd} = (T_{std}/T_n) - 1$$

$$= [T_{std}/(T_{std} - \text{allowances time})] - 1$$

$$480/(480-59) - 1 = 1.140 - 1 = 0.14$$

$$\text{Allowance factor } A_{pfd} = 0.140 = 14.0\%$$

۳۰



## Factors causing Fatigue in Workers

---

### 1- Physical Factors

- Standing, Abnormal body position (Awkward posture), Use of force, Expenditure of muscular energy

### 2- Mental & cognitive Factors

- Concentration & attention, mental strain, Monotony, Eye strain, Noise

### 3- Environmental & work Factors

- Poor lighting, Noise, Fumes, Heat, Atmospheric conditions (Ventilation), Dusts, Dirt, Wet

۳۱



## Calculate the PFD Allowance Time (Relaxation allowances)

---

- Direct calculation includes that:

PFD allowance = 5% of normal time (personal time) + 5% of normal time (low/medium fatigue allowances) OR 20% (high fatigue allowances) + 5% of normal time (delay allowances)

۳۲



## Other Types of Allowances

- There are other reasons for adding allowances, which are not as common as PFD allowances. They are applied in addition to  $A_{pfd}$
- **Contingency طوارئ allowance**
  - Additional allowance due to a problem with the task (e.g., raw material problem) - not greater than 5%
  - Temporary basis – after solving the underlying problem, it will disappear
- **Policy allowance: They are based on company policy**
  - Machine allowance - (set by company policy as a part of the wage incentives.)
  - Training allowance – for teaching new workers (for workers whose responsibilities include teaching other workers)
  - Learning allowance – learning a new task (for workers who are learning a new job, or new employees)

۳۳



## Contingency Allowances

Problem area	Problems and examples
Materials or parts	Starting materials or parts are out of specification, and extra time is needed to correct the nonconformance (e.g., oversized casting that requires an extra machining pass or slower feed rate).
Process	Manufacturing process is not in statistical control, and additional time is required to inspect every piece rather than inspect on a sampling basis.
Equipment	Equipment is malfunctioning or breaking down more frequently than what is provided by the unavoidable delay factor, and additional time is needed to compensate the worker to make adjustments, lubricate the machine more frequently, or other extra task(s) not included in the standard time.

۳۴



## PROBLEM # 12.7 (Page 341)

---

The work shift at the ABC Company runs from 7:30 a.m. to 4:15 p.m. with a 45 min break for lunch from 11:30 to 12:15 p.m. that does not count as part of the work shift (workers are not paid for this time). The company provides two 12-min rest breaks during working hours (paid time), one in the morning and one in the afternoon. The company also allows 25 min per day for personal needs (paid time). In addition, a work sampling study has shown that on average, unavoidable delays in the plant result in 20 min lost time per worker per day (paid time). Determine the PFD allowance factor for the following two management policies on allowances: (a) the two 12-min breaks are both scheduled breaks that all workers take at the same time (not included in the allowance time) and (b) the two 12-min breaks are included in the allowance factor so that workers can take their breaks whenever they please.

۳۰