# Introduction to Work Measurement

Sections:

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

# Introduction to Work Measurement

## *2. Prerequisites for Valid Time*

# Prerequisites for Valid Time

- In order to establish $T_{std}$ for task, following factors must be standardized:
  1. Task is performed by ***average worker***
  2. Worker's pace represents ***standard performance***
  3. Worker uses ***standard method***
  4. Task is performed on ***standard work unit*** that is defined
     a) before (input) &
     b) after processing (output)
- These definitions must be fully documented for future reference

# Prerequisites for Valid Time

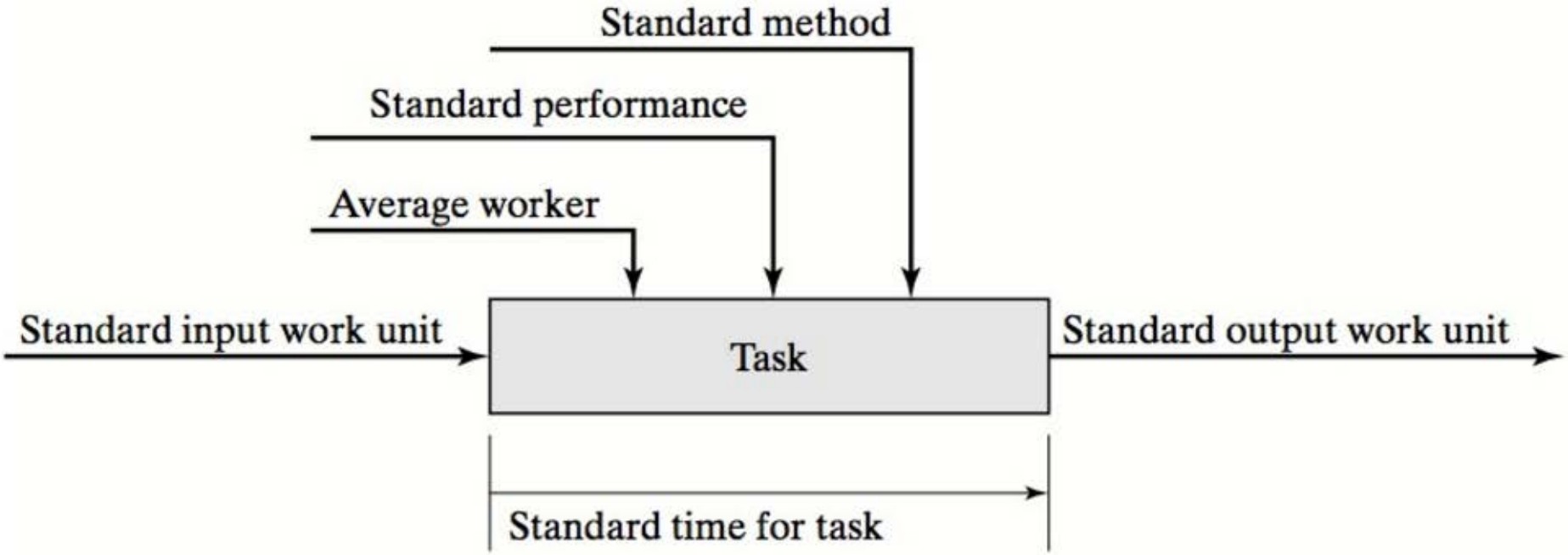


**Figure 3** Model indicating the factors that must be standardized before a standard time can be set for a task.

# 2.1 Average Worker & Standard Performance

- **Average Worker**:
  - person man/woman
  - representative of those who perform tasks similar to the task being measured
  - assumed to have,
    - learned task
    - practiced task and proficient at it
    - performed task consistently throughout shift

# 2.1 Average Worker & Standard Performance

- **Standard Performance**:
  - pace of working:
    - can be maintained by average worker throughout entire work shift,
    - without harmful effects on worker's health or physical well-being
    - worker can achieve this pace day after day
    - normal pace of average worker for given task

# 2.1 Average Worker & Standard Performance

- **Cont. Standard Performance**:
  - work shift:
    - usu. considered: 8-hour workday
    - worker: allowed periodic rest breaks, may experience other interruptions
  - example of benchmarks for standard performance:
    - walking @ $3\ mi/hr$ ($4.82\ km/hr$) on level flat ground

# 2.1 Average Worker & Standard Performance

- Worker performance:
  - varies among individual workers
  - variations occur due to,
    - age
    - sex
    - size/physical strength
    - physical conditioning
    - skill/aptitude for task
    - experience/training
    - motivation

# 2.1 Average Worker & Standard Performance

- Cont. worker performance:
  - For large numbers of workers, studies show:
    - worker performance: normally distributed
    - ratio of highest performing : lowest performing worker $= 2.3 : 1$
  - Worker performance:
    - usu. indicated by hourly or daily production rate for a representative manual task

# 2.1 Average Worker & Standard Performance

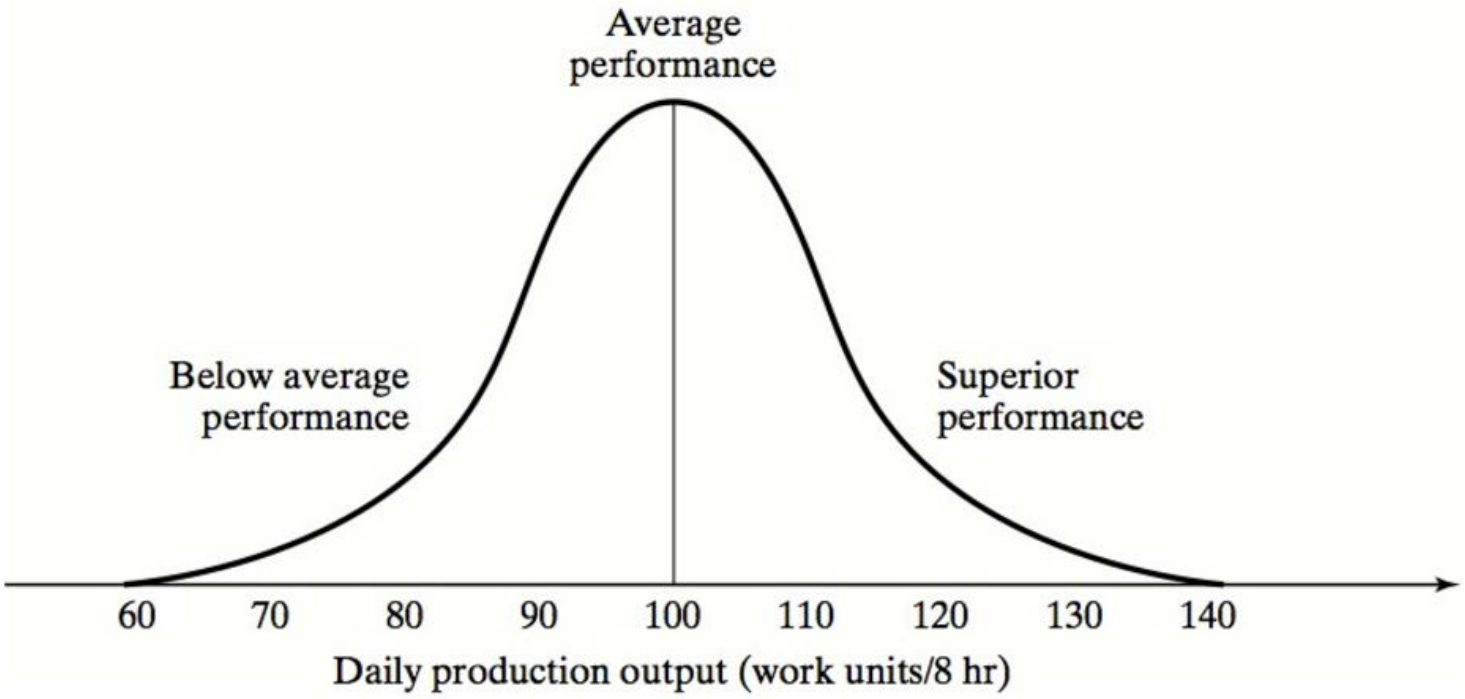


**Figure 4** Distribution of performance (daily production output) for large numbers of workers.

# 2.1 Average Worker & Standard Performance

- Cont. worker performance:
  - Companies:
    - want most workers to be able to achieve standard performance fairly easily
    - define standard to be performance < avg.
    - typical multiplier $= 1.30$

      i.e. average worker should be able to work at pace $= 130\%$ of defined standard pace*

# 2.1 Average Worker & Standard Performance

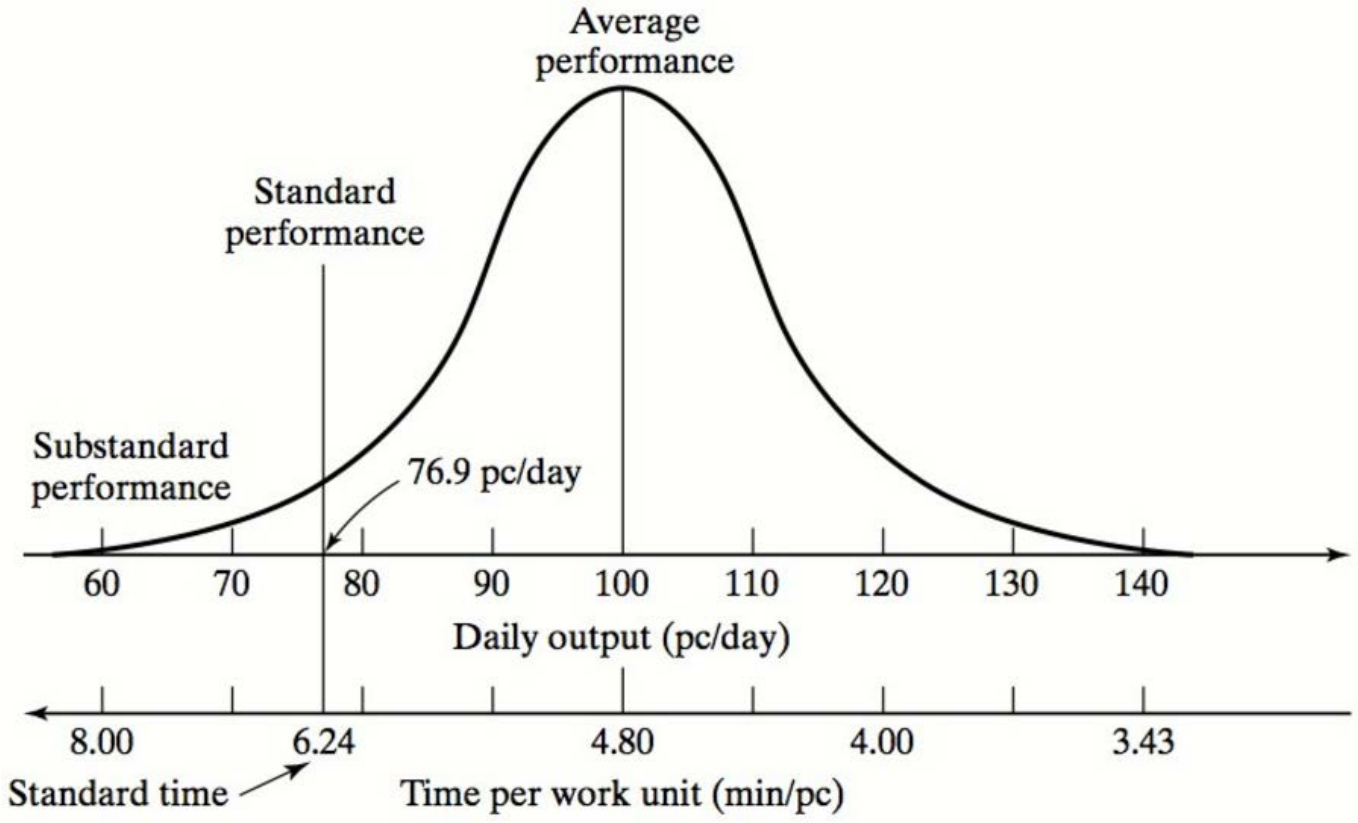


**Figure 5** Distribution of performance and task time for large numbers of workers, indicating how standard time is typically defined as a time that can be readily achieved by most workers.

# 2.1 Average Worker & Standard Performance

- Cont. worker performance:
  - **Standard Performance** (indust. practice def$^{n}$):
    - pace of working,
    - standard time for task = $130\%$ of mean time that can be maintained,
      - throughout an entire work shift
      - by average worker
      - without harmful effects on worker's health or physical well-being

# 2.2 Standard Method

- **Standard Method**:
  - *procedure* that has been determined to be *optimum method* for processing a work unit
  - safest, quickest, most productive, and least stressful procedure for worker
  - constrained by
    - practical conditions,
    - economic limitations of work environment
  - Should be documented in written statement
    - provide valuable description of task
    - used in resolving disputes regarding: standard method/standard time

# 2.2 Standard Method

- **Cont. Standard Method**:
  - should include following details about how a task is performed:
    - Procedure (actions & motions) used by worker
    - Tools (e.g. fixtures, gauges used)
    - Equipment (machinery and safety)
    - Workplace layout
    - Irregular work elements (tasks not performed every work cycle)
    - Working conditions (e.g. temperature, noise)
    - Setup (e.g. physical tools, setup time)

# Introduction to Work Measurement

## *3. Allowances in Time Standards*

# Allowances in Time Standards

- Allowance factor:
  - purpose: compensate for lost time by providing small increment of “allowance time” in each cycle
  - $\Rightarrow$ even with time losses, operator still able to complete fair day’s work during hours of shift

# Accounting for Lost Time in the Workplace

**TABLE 2** Typical Causes of Interruptions in the Workplace

| Causes of Work-Related Interruptions | Reasons for Nonwork Related Interruptions |
|---|---|
| Machine breakdowns or malfunctions | Personal needs (e.g., restroom interruption) |
| Waiting for materials, parts, or other items necessary to proceed with work | Talking to coworkers about matters unrelated to work |
| Receiving instructions from foreman | Lunch break |
| Talking to coworkers about job-related matters | Smoke break |
| Waiting at a tool crib for the attendant to deliver a tool | Beverage break |
| Rest breaks to overcome fatigue for physiologically demanding work | Personal telephone call |
| Cleaning up at the end of the shift | |

# Types of Allowances

- Common allowances:
  1. Scheduled Break Periods
  2. The PFD Allowance

- Other types of allowances (less common):
  3. Contingency Allowances
  4. Policy Allowances

# Types of Allowances

1. **Scheduled Break Periods**:
   - planned periods set aside during shift as break time from work
   - examples:
     - lunch breaks (noon – 12:30 PM)
     - rest breaks (paid)
       - 1 mid-morning; 1 mid-afternoon
       - usu. last ~15 min. each
     - Here: total paid hrs (8 AM – 4:30 PM) = 8*

# Types of Allowances

2. **The PFD Allowance**:
   - $A_{pfd}$: used in converting $T_n$ into $T_{std}$
   - Can be work related or non-work related
     - Personal time:
     - Fatigue allowance
     - Delays
     - P, F, D allowances combined into: $A_{pfd}$
   - **Personal time**:
     - e.g.: restroom breaks, phone calls, water fountain visits, etc.
     - typical allowance $= 5\%$

# Types of Allowances

2. **The PFD Allowance**:
   - **Fatigue**/rest **allowance:**
     - must be taken
     - used to overcome fatigue due to work-related stresses & conditions
     - e.g. work requiring physiologically significant metabolic energy
     - allowance:
       - fatigue in light – medium work: 5%
       - fatigue in heavy work: ≥ 20%

# Types of Allowances

**TABLE 3** Factors Causing Fatigue in Workers

| Physical Factors | Mental and Cognitive Factors | Environmental and Work Factors |
|---|---|---|
| Standing | Concentration and attention | Poor lighting |
| Abnormal body position | Mental strain | Noise |
| Use of force | Monotony and tediousness | Fumes |
| Expenditure of muscular energy | Eyestrain | Heat |
| | | Atmospheric conditions |

# Types of Allowances

2. **The PFD Allowance**:
   - **Delays:**
     - occur at random times during day
     - usually refer to
       - work-related events
       - delays: responsibility of management
     - examples:
       - machine breakdown
       - waiting for parts or tools
       - waiting for elevator
       - waiting for foreman's instructions
     - harder to find than *P* or *F* delays*

# Types of Allowances

3. **Contingency Allowances**:
   - usu. due to some problem with task or production equipment used to perform it
   - should not be $>$ 5%

**TABLE 4** Examples of Problems for Which Contingency Allowances Might Be Provided

| 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 | The manufacturing process is not in statistical control (too much variability), 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. |

# Types of Allowances

4. **Policy Allowances**:
   - cover special work situations associated with wage incentive system
   - e.g.: machine allowance:
     - added to machine-paced portion of work cycle in operation of worker-machine system
     - provides opportunity for worker to maintain a high rate of earnings
   - other types of policy allowances:
     - training allowances (teaching other workers)
     - learning allowances (new employees)

# Types of Allowances

4. **Policy Allowances**:

$$T_{std} = T_{nw}(1 + A_{pfd}) + T_m(1 + A_m)$$

- $T_{nw}$: normal time of worker during the worker-controlled portion of the cycle, min
- $A_{pfd}$: PFD allowance
- $T_m$: machine cycle time, min
- $A_m$: machine allowance
  - If company policy does not recognize separate machine allowance $\Rightarrow$
    - $A_m = 0$, or
    - set equal to value of $A_{pfd}$

# Types of Allowances

## 4. Policy Allowances

**Example 1 Use of Machine Allowance in a Wage Incentive Plan**

A wage incentive plan pays workers a daily wage at a rate of $15.00/hr multiplied by the number of standard hours accomplished during the shift. One worker-machine task in the plant includes worker-paced elements totaling a normal time of 1.00 min and machine-paced elements with a time of 3.00 min. The PFD allowance is 15%. Determine the standard time for the task given that (a) $A_m = 0$ and (b) $A_m = 30\%$. (c) What does a worker earn for the day under each policy if he or she produces 115 parts that day?

# Types of Allowances

## 4. Policy Allowances

**Solution:** **(a)** $T_{std} = 1.00\,(1 + 0.15) + 3.00\,(1 + 0) = 1.15 + 3.00 = 4.15$ min.

**(b)** $T_{std} = 1.00\,(1 + 0.15) + 3.00\,(1 + 0.30) = 1.15 + 3.90 = 5.05$ min.

**(c)** For the standard of 4.15 min, the number of standard hours is $H_{std} = 115(4.15)/60 = 7.95$ hr and the worker's earnings would be \$15.00 (7.95) = \$119.25.[6]

For $T_{std} = 5.05$ min, $H_{std} = 115(5.05)/60 = 9.68$ hr and the worker's earnings would be \$15.00(9.68) = \$145.19.