



# Introduction to Work Measurement

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Sections:

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



# Introduction – Some Definitions

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- *Time Study, Work Measurement.*
  - often used interchangeably
  - meaning: **time to complete a unit of work**



# Introduction – Some Definitions

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- **Work Measurement:**
- 4 techniques to evaluate task i.t.o. time allowed for average worker to perform that task:
  1. direct time study (DTS)
  2. predetermined motion time systems (PMTS)
  3. standard data systems (SDS), and
  4. work sampling
- task that is measured: usu. repetitive work cycle
- objective of work measurement techniques:
  - determine **standard time** ( $T_{std}$ ) for task



# Introduction to Work Measurement

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- 1. Time Standards and How They Are Determined***

# Time Standards and How They Are Determined

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- ***standard time*** for given task:
  - amount of time allowed for average worker,
    - to process 1 work unit
    - using standard method
    - and working at normal pace
  - includes also additional time: ***allowance***,
    - worker's *personal* needs
    - worker *fatigue*,
    - and unavoidable *delays* during the shift
  - ⇒ std. time aka ***allowed time***

# Time Standards and How They Are Determined

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- **Applications in which time standards are useful:**
  - Low productivity: need for improvement
  - Repeat orders
    - set time standard for 1<sup>st</sup> order
    - $\Rightarrow$  same standard used for successive orders
  - Long production runs
    - time to set standard: divided over more parts
    - $\Rightarrow$  average cost of work measurement  $\downarrow$
  - Repetitive work cycles: justifies work measurement
  - Short cycle times (work cycles): require less time to set standards



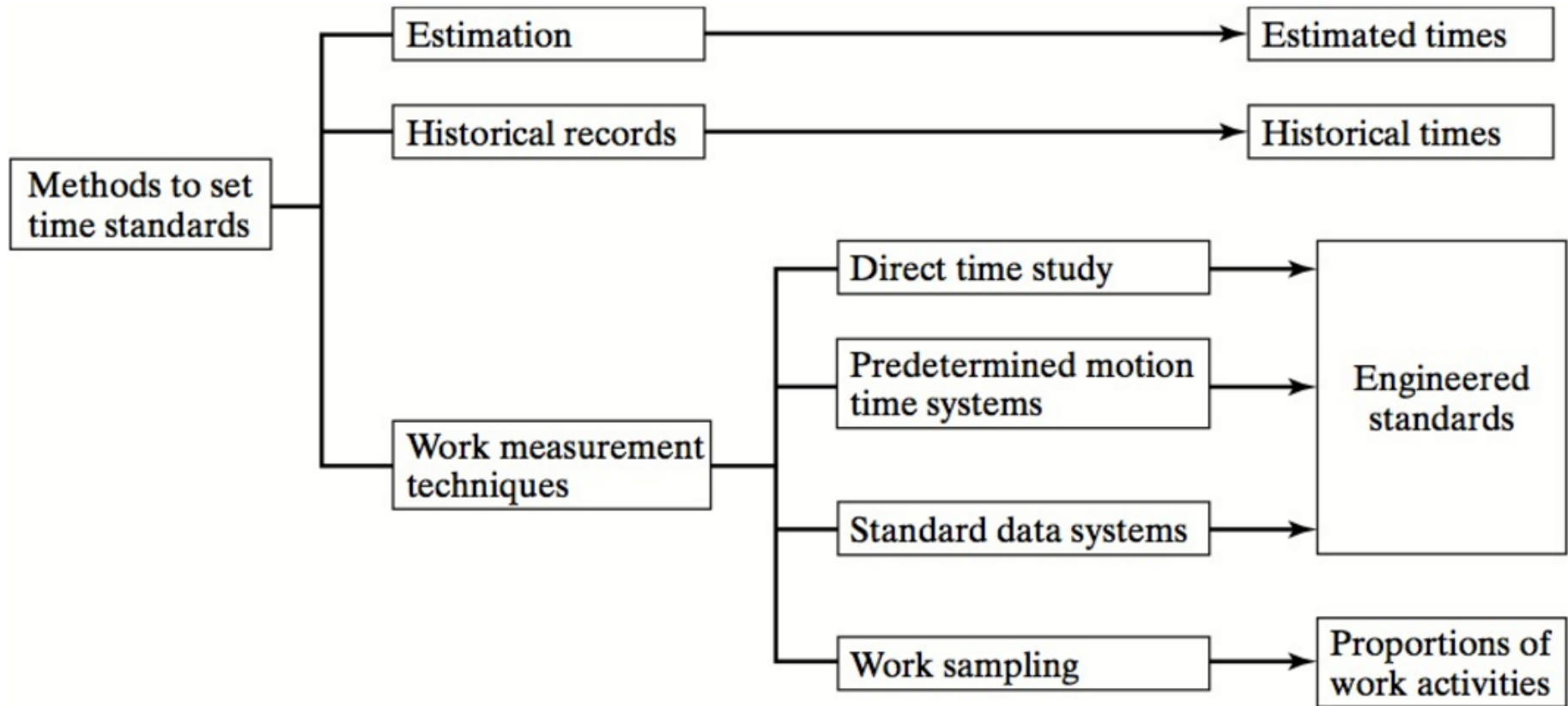
# Time Standards and How They Are Determined

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- **Functions/advantages of time standards :**
  - Determine a “fair day’s work”:
    - i.e. number of hrs in shift (e.g. 8 hrs) should =  
# of completed work units \* respective  $T_{std}$
  - Converting workload into manpower and equipment resources to accomplish workload
  - Objective way to compare alternative methods for accomplishing same task
  - Evaluating worker performance
  - Functions that depend on task time data:
    - Production planning, scheduling cost estimating, material requirements planning



# Methods to Determine Time Standards



**Figure 1** Classification of methods to determine time standards.





# Methods to Determine Time Standards

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- Methods (vary i.t.o. *accuracy* and *reliability*):
  - Estimation:
    - department *foreman* determines time that should be allowed for given task
    - $\Rightarrow$  least accurate of techniques (subjective)
  - Historical records of previous production runs:
    - records of previous identical/similar job orders used to determine time standards
    - average time/part calculated from worker “time cards”
    - disadvantage: don’t indicate work efficiency
  - Work measurement techniques: most acc. (next)



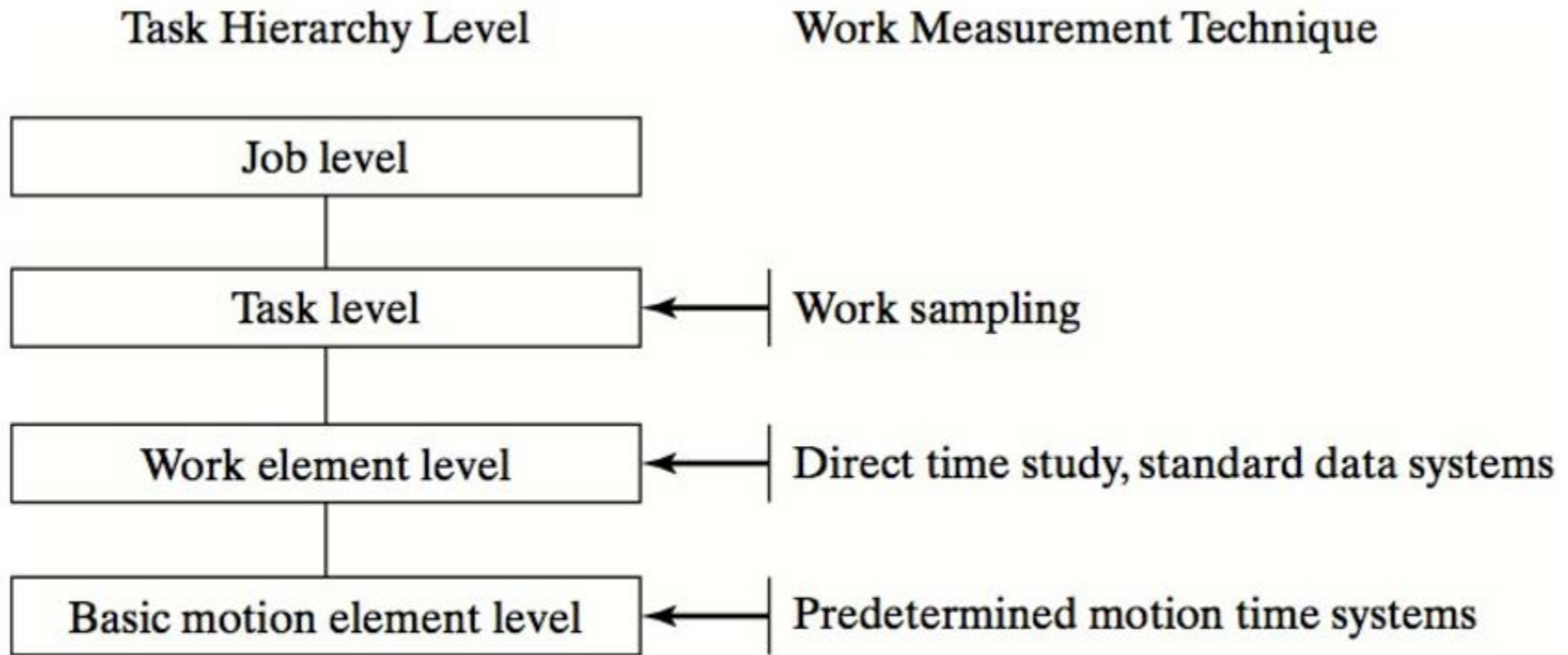
# Methods to Determine Time Standards

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- **Cont. Methods** (see [figure 1](#))
  - Work measurement techniques
    - Work sampling:
      - different from other 3 techniques
      - determines proportions of time spent in various categories of work activity
      - uses randomized observations of subjects
    - Other 3 techniques (DTS, PMTS, SDS):
      - establish time/**engineering standards**:
        - based on time values adjusted for worker performance
        - effort needed to find best method



# Work Measurement Techniques



**Figure 2** How the work measurement techniques correspond to different levels in the general task hierarchy.



# Work Measurement Techniques

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- **Direct Time Study (DTS):**
  - direct observation of task
    - using stopwatch/chronometric device
    - records time taken to accomplish task
  - task usu. divided into work elements
  - each work element is timed separately
  - time study analyst (while observing worker):
    - evaluates worker's performance (**pace**)
    - records pace to each work element time
    - this's called *performance rating*



# Work Measurement Techniques

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- **Cont. Direct Time Study (DTS):**

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

- $T_n$ : **normal time** for element/task\* (time req. by worker working @ 100% pace for *1 cycle*), min
- $T_{obs}$ : **observed time**, min
- $PR$ : **performance rating** of worker's pace
  - observed by analyst
  - usu. recorded as %ge during observation
  - applied as decimal fraction in equation
- If task is repetitive,
  - several work cycles observed,
  - $T$ -values avg. to improve statistical accuracy



# Work Measurement Techniques

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- *cont.* **Direct Time Study (DTS):**

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

- $T_{std}$ : **standard time**, min.
- $T_n$ : **normal time**
- $A_{pfd}$ : **allowance** for
  - **personal time,**
  - **fatigue,**
  - **delays**



# Work Measurement Techniques

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- **Predetermined Motion Time Systems (PMTS):**
  - relies: database of *basic motion elements*
    - e.g. reach, grasp, move, other *therbligs*
  - with each motion element:
    - set of  $T_n$ 's,
    - values of  $T_n$ 's depend on *conditions* under which motion element was performed
    - e.g.  $T_n$  for move depends on :
      - distance reached
        - longer distances  $\Rightarrow$  more time
      - also on weight of moved object



# Work Measurement Techniques

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- **Predetermined Motion Time Systems (PMTS):**
  - analyst activities:
    - analyst lists all BME's for task (& conditions)
    - retrieves  $T_n$  (each BME) from database
    - $T_n(\text{task}) = \sum T_n(\text{BME's})$
    - $T_{std} = T_n (1 + A_{pfd})$  (i.e. same as in DTS)
  - advantages of PMTS:
    1. performance rating: not required,
    2. can be applied to find  $T_{std}(\text{task})$  *before* production





# Work Measurement Techniques

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- **Standard Data Systems (SDS):**
  - compilation of  $T_n$ 's for *work elements*,
    - used in tasks performed in given facility
    - used to find  $T_{std}$ 's
      - tasks composed of work elements,
      - *similar to* those in database
  - advantage of SDS:
    - $T_{std}$  can be set *before* job is in production
  - $T_n$ 's obtained from:
    - previous DTS's, or PMTS data, or WS data
    - or even historical time records
  - large data amounts req. to build database



# Work Measurement Techniques

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- ***cont.* Standard Data Systems (SDS):**
  - analyst activities:
    - identifies:
      - *work elements* that make up task &
      - values of work variables for each element
    - retrieves  $T_n$  (each WE\*) from database
    - $T_n(\text{task}) = \sum T_n(\text{WE's})$
    - $T_{std} = T_n (1 + A_{pfd})$   
(i.e. same as in DTS, PMTS)



# Work Measurement Techniques

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- **Work Sampling:**
  - uses random sampling techniques to study work situations
  - $\Rightarrow$  proportions of time spent in different activities: estimated with defined deg. of stat. accuracy
  - e.g. setting up for production, producing parts, machine idle
  - advantage of work sampling:
    - can include multiple subjects (e.g. workers, machines)
    - DTS, PMTS: limited to 1 worker/study



# Work Measurement Techniques

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- Work Sampling:
  - to achieve desired level of statistical accuracy:
    - large # of observations
    - over long period of time
    - observations must be made @ random times (⇒ minimize bias)
  - objectives in work sampling study (e.g.'s):
    - measure machine utilization in plant
    - appropriate allowance factor for use in setting  $T_{std}$  in DTS (i.e. not always finding  $T_{std}$ )
  - Disadvantage of work sampling:
    - $T_{std}$  in WS: less acc. than other techniques\*



# Work Measurement Techniques

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- **Computerized Work Measurement:**
  - Software/hardware products:
    - improve productivity of analysts (performing work measurement)
    - reduce time req. by analyst to set  $T_{std}$
    - developed for all 4 work measurement techniques: DTS, PMTS, SDS, WS
    - used with
      - PC's
      - PDA's (portable digital assistants)





# Work Measurement Techniques

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- **Computerized Work Measurement:**
  - advantages:
    - facilitate collecting data at work site (DTS, WS)
    - perform routine computations (instead of analyst)
    - organizing  $T_{std}$  files & databases
    - retrieving data from databases (PMTS, SDS)
    - documentation req. in work measurement (e.g. methods descriptions, reports)



# Work Measurement Techniques

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- Useful videos to watch on **work measurement**:  
<https://youtu.be/QzZKXC5KJrI>  
<https://youtu.be/hzYXtZn1MMw>  
<https://youtu.be/cWrsDCIWRgc>
- Useful video to watch on **time motion study**:  
<https://youtu.be/IUu9CNuKGYy>  
<https://youtu.be/O77eIB7-CYE> (second half)