Direct Time Study

Sections:

1. Direct Time Study Procedure – **part 1**
2. Number of Work Cycles to be Timed – **part 2**
3. Performance Rating – **part 2**
4. Time Study Equipment – **part 2**

Direct Time Study - Defined

- **Direct Time Study**:
  - aka **stopwatch time study**
  - **direct** & **continuous observation** of task
  - using **stopwatch** or other timekeeping device
  - to **record time** taken **to accomplish task**

- ANSI definition:
  - careful time measurement of task
  - using time measuring instrument
  - allows adequate time (foreign elements, delays, fatigue, and personal needs)
  - task usu. broken down into work elements

Direct Time Study - Defined

- While **observing** & **recording time**
  - **appraisal** of **worker's performance** level is made
  - data then used to **compute** ***standard time*** for task (after adding A_{pfd})

Direct Time Study - Defined

- Background:
  - first work measurement technique (**1883**)
  - connected with origins of IE
  - computerized techniques improved DTS i.t.o
    - accuracy
    - application speed of DTS
    - database management functions that support it

Direct Time Study - Defined

- Applications:
  - tasks that involve **repetitive** work cycle
  - at least a portion of which is **manual**
  - common in batch & mass **manufacturing**
- Limitations:
  - **time-consuming** ⇒ justified when,
    - job has relatively long production run
    - will be repeated in the future
  - cannot be used to set T_{std} prior to start of production

Direct Time Study

1. *Direct Time Study Procedure*

Direct Time Study Procedure

1. Define & document **standard method**
2. Divide task into **work elements**
   - Note 1 & 2: before actual timing begins
3. Time work elements to get **observed time, T_{obs}**
4. Evaluate **worker**'s pace relative to standard **performance** to obtain **normal time** T_n
   - Called **performance rating** (*PR*):

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

   - Note steps 3 & 4: done at same time; for several work cycles; values: averaged*
5. Apply **allowance factor** to compute standard time

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

1. Document the Standard Method

- Methods engineering study and documentation:
  - **Determine** the "one **best method**"
  - Then document:
    - all **steps** in method,
    - hand & body **motions**
    - **special tools**, gauges, equipment, equipment **settings** (e.g., feeds, speeds),
    - **irregular elements** & their frequency
    - workplace **layout**, working **conditions**
    - all included in,
      - "**methods description form**"
      - videotape: for complex tasks

1. Document the Standard Method

- Seek worker's **advice** if possible
- **Once** standard method is **defined,**
  - it should **not** be possible for operator to make **further improvements**

Form to document the **standard method**

Date	**Standard Method Description for Direct Time Study**	Page of

Operation	Dept.	Part No.
Machine	Analyst	

Methods Improvements (check if implemented)	Sketch of Workplace:

Work Element No. and Description with Machine Parameters for Machine Cycles	Freq.	Tools and Gauges

Additional Notes

Why Documentation is Important

- **Batch production**
  - **repeat orders** after a significant time lapse
- **Methods improvements** by operator*
  - to restudy task, must be able to **prove** a **change** has occurred
- **Disputes** about method
  - **operator complains** that standard is too tight
  - is operator **using standard method**?
- Data for **standard data system**
  - good documentation is essential for developing a standard data system

2. Divide Task into Work Elements

Guidelines:

- Each **work element** should consist of a **logical group of motion elements** with unified purpose
- **Beginning** point of **one element** should be **end point** of **preceding element**
- Each element should have a **readily identifiable end point**
- Work elements should **not** be
  - **too long**
  - nor **too short**
- Separate **irregular elements**, **machine elements**, **internal elements**

2. Divide Task into Work Elements

TABLE 1 Guidelines for Defining the Work Elements in Direct Time Study

Guideline	Explanation and Examples
Each work element should consist of a logical group of motion elements.	The work element should have a unified purpose, such as reaching for an object and moving it to a new location (e.g., reach, grasp, move, and place). There would be no purpose in separating the reach from the move motions since they both involve the same object.
Beginning point of one element should be end point of preceding element.	There should be no gap between one element and the next in the task sequence. Otherwise, the time of the gap is omitted from the recorded total time.
Each element should have a readily identifiable end point.	A readily identifiable end point can be easily detected during the study. It can often be anticipated to allow reading of the watch more conveniently. An audible sound, such as the actuation of a pneumatic device, provides a readily identifiable end point.
Work elements should not be too long.	If a work element is very long (i.e., several minutes), it should probably be divided into multiple elements that are timed separately. Machine semiautomatic cycle time is an exception. Some machine cycles can take several minutes and should be identified as one element.
Work elements should not be too short.	A practical lower limit in direct time study is around 3 sec. Below this, reading accuracy may suffer. If a video camera is used for timing purposes, shorter elements may be possible.

2. Divide Task into Work Elements

TABLE 1 Guidelines for Defining the Work Elements in Direct Time Study

Guideline	Explanation and Examples
Irregular work elements should be identified and distinguished from regular elements.	Irregular elements are work elements that do not occur every cycle. The frequency with which they should be performed must be noted. The time(s) for the irregular element(s) are prorated across the regular work cycle when the standard time is computed.
Manual elements should be separated from machine elements.	Manual elements depend on the operator's performance (pace) and therefore vary over time. Machine elements are generally constant values that depend on machine settings. Once the settings are established, the actuation time shows no perceptible variation.
Internal elements should be separated from external elements.	Internal elements are performed by the operator during the machine cycle. In most cases, they do not affect the overall work cycle time. External elements are performed outside of the machine cycle. They contribute to the overall work cycle time.

3. Time the Work Elements

- Time data usu. recorded on **DTS form**

- **Each element should be timed**
  - over **several work cycles**
  - to obtain a **reliable average**
  - **number of cycles** determined using statistical techniques (later)

Direct time study form

Date	Direct Time Study Observation Form		Page of
Operation		Dept.	Part No.
Machine			Tooling
Worker			Worker No.
Analyst	Start Time	Finish Time	Elapsed Time

Work Elements, Machine Settings, and Observations				Cycle No. (regular elements)										
Element Number and Description	Feed	Speed		1	2	3	4	5	6	7	8	9	10	Avg T_n
1			T_{obs}											
			PR											
			T_n											
2			T_{obs}											
			PR											
			T_n											
3			T_{obs}											
			PR											
			T_n											
4			T_{obs}											
			PR											
			T_n											
5			T_{obs}											
			PR											
			T_n											
6			T_{obs}											
			PR											
			T_n											
7			T_{obs}											
			PR											
			T_n											
8			T_{obs}											
			PR											
			T_n											
Normal time = Sum of T_n (regular work elements)														

Irregular Element and Description	Freq	T_0	T_f	PR	T_n		Calculation of Standard Time T_{std}	
A							Sum of T_n (regular work elements)	
B							Sum of freq x T_n (irregular elements)	
C							Total T_n per cycle	
D							PFD allowance A_{pfd}	
E							Standard time $T_{std} = T_n(1 + A_{pfd})$	

Additional Notes

3. Time the Work Elements

- Stopwatch timing methods:
  1. **Snapback timing method**
     - stopwatch is **reset to zero** at the start of **each work element**
     - reader must **record final time** for element just as watch is being zeroed
  2. **Continuous timing method**
     - stopwatch: allowed to **run continuously** throughout duration of work cycle
     - analyst **records running time** on stopwatch at end of each element
     - may zero at beginning of each work cycle $\Rightarrow$ starting time of any cycle always $= 0$

Advantages of Each Timing Method

- Advantages of **snapback method**:
  - **Analyst** can readily see how **element times vary** from cycle to cycle
  - **No subtraction** necessary to obtain **individual element times**

- Advantages of **continuous method**:
  - **Elements cannot be omitted** by mistake
  - **Regular and irregular elements** can be more **readily distinguished**
  - **Manipulation** and **resetting** of the stopwatch is **reduced**

4. Performance Rating

- Analyst simultaneously
  - **observe performance** of worker
  - AND **judge performance**/pace of worker
    - **relative to** definition of **standard performance** used by organization

- **Standard performance:** $\boldsymbol{PR = 100\%}$
  - **Slower** pace than standard: $\boldsymbol{PR < 100\%}$
    $\Rightarrow$ longer T_{obs} (for work cycle)
  - **Faster** pace than standard $\boldsymbol{PR > 100\%}$
    $\Rightarrow$ shorter T_{obs}
- **Normal time** for element/cycle: $\boldsymbol{T_n = T_{obs}\,(PR)}$

4. Performance Rating

- Notes regarding performance rating:
  - most difficult & controversial step in DTS
    - since requires judgment of **analyst** to **assess value of PR**
  - It is in **worker's interest** & advantage **to receive high PR during study**
    - $\Rightarrow$ T_n and T_{std} for task will be longer
    - $\Rightarrow$ looser standard
    - $\Rightarrow$ easier for worker to achieve a higher efficiency level as job continues
    - this's important to worker if s/he paid on wage incentive plan

5. Apply Allowances

- A PFD allowance is added to the normal time to **compute standard time**

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

  - where A_{pfd} = allowance factor
    - *P*ersonal time
    - *F*atigue
    - *D*elays
- The function of **allowance factor**:
  - **inflate** value of **standard time**
  - **accounts** for various reasons **why worker loses time** during shift

Example 1

- A direct time study was taken on a manual work element using the snapback method. The regular cycle consisted of three elements, *a*, *b*, and *c*. Element *d* is an irregular element performed every 5 cycles.

Work element	a	b	c	d
Observed time (min)	0.56	0.25	0.50	1.10
Performance rating	100%	80%	110%	100%

- Determine (a) normal time and (b) standard time for the cycle using an allowance factor of 15%.*

Solution

(a) Normal time:

$$T_n = 0.56(1.00) + 0.25(0.80) + 0.50(1.0) + 1.10(1.0)/5$$

$$= 0.56 + 0.20 + 0.55 + 0.22$$

$$= 1.53 \text{ min}$$

(b) Standard time:

$$T_{std} = 1.53\,(1 + 0.15) = 1.76 \text{ min}$$

5. Apply 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}

Example 2

Example 2 Determining a Standard Time for a Task That Includes a Machine Cycle

The snapback timing method was used in a direct time study of a task that includes a machine cycle. Elements *a*, *b*, *c*, and *d* are performed by the operator, and element *m* is a machine semi-automatic cycle. Element *b* is an internal element performed simultaneously with element *m*, and element *d* is an irregular element performed once every 15 cycles. Observed times and performance ratings are given in the table below. The PFD allowance factor is 15%, and the machine allowance is 20%. Determine (a) the normal time and (b) the standard time for the work cycle.

Worker element	*a*	*b*	*c*	*d*
Observed time, manual	0.22 min	0.65 min	0.47 min	0.75 min
Performance rating	100%	80%	100%	100%
Machine element		*m*		
Observed time, machine	(idle)	1.56 min	(idle)	(idle)

Solution

Solution **(a)** The normal time must take account of which element, *b* or *m*, has the larger value. Also, element *d* must be prorated across 15 cycles.

$$T_n = 0.22(1.00) + \text{Max}\{0.65(0.80), 1.56\} + 0.47(1.00) + 0.75(1.00)/15$$
$$= 0.22 + 1.56 + 0.47 + 0.05 = 2.30 \text{ min}$$

(b) The same comparison between elements *b* and *m* must be made in computing the standard time.

$$T_{std} = (0.22 + 0.47 + 0.05)(1 + 0.15)$$
$$+ \text{Max}\{0.52(1 + 0.15), 1.56(1 + 0.20)\}$$
$$= 0.85 + 1.87 = 2.72 \text{ min}$$

■