# PREDETERMINED TIME SYSTEMS: METHODS-TIME MEASUREMENT

IENG 301

FUNDAMENTALS OF WORK STUDY AND ERGONOMICS

# METHODS TIME MEASUREMENT (MTM)

- This system is defined as a procedure which analyzes any manual operation or method into basic motions require to perform it, and assigns to each motion a predetermined time standard which is determined by the nature of the motion and the conditions under which it is made.

# MTM-1

- The unit of time used is one hundred-thousandth of an hour (0.00001 hour), and is referred to as one time-measurement unit (TMU). Thus, one TMU equals 0.0006 minute.

# Reach

- Reach is the basic element used when the predominant purpose is to move hand or finger to a destination. The time for making a reach varies with the following factors:
  - Condition (nature of destination)
  - Length of the motion
  - Type of reach

**Table 35.** Reach—R

| Distance Moved Inches | Time TMU | | | | Hand in Motion | | Case and Description |
|---|---|---|---|---|---|---|---|
| | A | B | C or D | E | A | B | |
| ¾ or less | 2.0 | 2.0 | 2.0 | 2.0 | 1.6 | 1.6 | A Reach to object in fixed location, or to object in other hand or on which other hand rests. |
| 1 | 2.5 | 2.5 | 3.6 | 2.4 | 2.3 | 2.3 | |
| 2 | 4.0 | 4.0 | 5.9 | 3.8 | 3.5 | 2.7 | |
| 3 | 5.3 | 5.3 | 7.3 | 5.3 | 4.5 | 3.6 | B Reach to single object in location which may vary slightly from cycle to cycle. |
| 4 | 6.1 | 6.4 | 8.4 | 6.8 | 4.9 | 4.3 | |
| 5 | 6.5 | 7.8 | 9.4 | 7.4 | 5.3 | 5.0 | |
| 6 | 7.0 | 8.6 | 10.1 | 8.0 | 5.7 | 5.7 | |
| 7 | 7.4 | 9.3 | 10.8 | 8.7 | 6.1 | 6.5 | C Reach to object jumbled with other objects in a group so that search and select occur. |
| 8 | 7.9 | 10.1 | 11.5 | 9.3 | 6.5 | 7.2 | |
| 9 | 8.3 | 10.8 | 12.2 | 9.9 | 6.9 | 7.9 | |
| 10 | 8.7 | 11.5 | 12.9 | 10.5 | 7.3 | 8.6 | |
| 12 | 9.6 | 12.9 | 14.2 | 11.8 | 8.1 | 10.1 | |
| 14 | 10.5 | 14.4 | 15.6 | 13.0 | 8.9 | 11.5 | D Reach to a very small object or where accurate grasp is required. |
| 16 | 11.4 | 15.8 | 17.0 | 14.2 | 9.7 | 12.9 | |
| 18 | 12.3 | 17.2 | 18.4 | 15.5 | 10.5 | 14.4 | |
| 20 | 13.1 | 18.6 | 19.8 | 16.7 | 11.3 | 15.8 | |
| 22 | 14.0 | 20.1 | 21.2 | 18.0 | 12.1 | 17.3 | E Reach to indefinite location to get hand in position for body balance or next motion or out of way. |
| 24 | 14.9 | 21.5 | 22.5 | 19.2 | 12.9 | 18.8 | |
| 26 | 15.8 | 22.9 | 23.9 | 20.4 | 13.7 | 20.2 | |
| 28 | 16.7 | 24.4 | 25.3 | 21.7 | 14.5 | 21.7 | |
| 30 | 17.5 | 25.8 | 26.7 | 22.9 | 15.3 | 23.2 | |
| Additional | 0.4 | 0.7 | 0.7 | 0.6 | | | TMU per inch over 30 inches |

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# Reach

- There are three types of reach and move
  1. Hand is not moving at the beginning and at the end of reach/move
  2. Hand is moving at either beginning or end of reach/move
  3. Hand is in motion at both beginning and end of reach/move

# Move

- Move is the basic element used when the predominant purpose is to transport an object to a destination.
- The time for move is affected by the following variables:
    - Condition (nature of destination)
    - Length of motion
    - Type of move
    - Weight factor (static and dynamic)

**Table 36.** Move—M

| Distance Moved Inches | Time TMU | | | | Wt. Allowance | | | Case and Description |
|---|---|---|---|---|---|---|---|---|
| | A | B | C | Hand In Motion B | Wt. (lb.) Up to | Dynamic Factor | Static Constant TMU | |
| ¾ or less | 2.0 | 2.0 | 2.0 | 1.7 | | | | |
| 1 | 2.5 | 2.9 | 3.4 | 2.3 | 2.5 | 1.00 | 0 | |
| 2 | 3.6 | 4.6 | 5.2 | 2.9 | | | | A Move object to other hand or against stop. |
| 3 | 4.9 | 5.7 | 6.7 | 3.6 | 7.5 | 1.06 | 2.2 | |
| 4 | 6.1 | 6.9 | 8.0 | 4.3 | | | | |
| 5 | 7.3 | 8.0 | 9.2 | 5.0 | 12.5 | 1.11 | 3.9 | |
| 6 | 8.1 | 8.9 | 10.3 | 5.7 | | | | |
| 7 | 8.9 | 9.7 | 11.1 | 6.5 | 17.5 | 1.17 | 5.6 | |
| 8 | 9.7 | 10.6 | 11.8 | 7.2 | | | | |
| 9 | 10.5 | 11.5 | 12.7 | 7.9 | 22.5 | 1.22 | 7.4 | B Move object to approximate or indefinite location. |
| 10 | 11.3 | 12.2 | 13.5 | 8.6 | | | | |
| 12 | 12.9 | 13.4 | 15.2 | 10.0 | 27.5 | 1.28 | 9.1 | |
| 14 | 14.4 | 14.6 | 16.9 | 11.4 | | | | |
| 16 | 16.0 | 15.8 | 18.7 | 12.8 | 32.5 | 1.33 | 10.8 | |
| 18 | 17.6 | 17.0 | 20.4 | 14.2 | | | | |
| 20 | 19.2 | 18.2 | 22.1 | 15.6 | 37.5 | 1.39 | 12.5 | |
| 22 | 20.8 | 19.4 | 23.8 | 17.0 | | | | |
| 24 | 22.4 | 20.6 | 25.5 | 18.4 | 42.5 | 1.44 | 14.3 | C Move object to exact location. |
| 26 | 24.0 | 21.8 | 27.3 | 19.8 | | | | |
| 28 | 25.5 | 23.1 | 29.0 | 21.2 | 47.5 | 1.50 | 16.0 | |
| 30 | 27.1 | 24.3 | 30.7 | 22.7 | | | | |
| Additional | 0.8 | 0.6 | 0.85 | | TMU per inch over 30 inches | | | |

8

# Turn

- Turn is the motion employed to turn hand, either empty or loaded, by a movement that rotates the hand, wrist and forearm about the long axis of the forearm

- The time depends on two variables;
  - Degrees turned
  - Weight factor

**Table 37.** Turn—T

| Weight | Time TMU for Degrees Turned | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30° | 45° | 60° | 75° | 90° | 105° | 120° | 135° | 150° | 165° | 180° |
| Small—0 to 2 Pounds | 2.8 | 3.5 | 4.1 | 4.8 | 5.4 | 6.1 | 6.8 | 7.4 | 8.1 | 8.7 | 9.4 |
| Medium—2.1 to 10 Pounds | 4.4 | 5.5 | 6.5 | 7.5 | 8.5 | 9.6 | 10.6 | 11.6 | 12.7 | 13.7 | 14.8 |
| Large—10.1 to 35 Pounds | 8.4 | 10.5 | 12.3 | 14.4 | 16.2 | 18.3 | 20.4 | 22.2 | 24.3 | 26.1 | 28.2 |

# Apply Pressure

- It provides full cycle time or developments by the components as related to other motions

**Table 38.** Apply Pressure—AP

| Full Cycle | | | Components | | |
|---|---|---|---|---|---|
| Symbol | TMU | Description | Symbol | TMU | Description |
| APA | 10.6 | AF + DM + RLF | AF | 3.4 | Apply Force |
| | | | DM | 4.2 | Dwell, Minimum |
| APB | 16.2 | APA + G2 | RLF | 3.0 | Release Force |

# Grasp

- Grasp is the basic element employed when the predominant purpose is to secure sufficient control of one or more objects with the fingers or hand to permit the performance of the next required basic element.

**Table 39.** Grasp—G

| Type of Grasp | Case | Time TMU | Description | |
|---|---|---|---|---|
| Pick-up | 1A | 2.0 | Any size object by itself, easily grasped | |
| | 1B | 3.5 | Object very small or lying close against a flat surface | |
| | 1C1 | 7.3 | Diameter larger than ½" | Interference with Grasp on bottom and one side of nearly cylindrical object. |
| | 1C2 | 8.7 | Diameter ¼" to ½" | |
| | 1C3 | 10.8 | Diameter less than ¼" | |
| Regrasp | 2 | 5.6 | Change grasp without relinquishing control | |
| Transfer | 3 | 5.6 | Control transferred from one hand to the other. | |
| Select | 4A | 7.3 | Larger than 1" x 1" x 1" | Object jumbled with other objects so that search and select occur. |
| | 4B | 9.1 | ¼" x ¼" x ⅛" to 1" x 1" x 1" | |
| | 4C | 12.9 | Smaller than ¼" x ¼" x ⅛" | |
| Contact | 5 | 0 | Contact, Sliding, or Hook Grasp. | |

# Position

- Position is the basic element employed to align, orient and engage one object with another object, where the motions used are so minor that they do not justify classification as other basic elements.

- The time for position is affected by;
  - Class of fit
  - Symmetry
  - Ease of handing

**Table 40.** Position *—P

| Class of Fit | | Symmetry | Easy to Handle | Difficult to Handle |
|---|---|---|---|---|
| 1—Loose | No pressure required | S | 5.6 | 11.2 |
| | | SS | 9.1 | 14.7 |
| | | NS | 10.4 | 16.0 |
| 2—Close | Light pressure required | S | 16.2 | 21.8 |
| | | SS | 19.7 | 25.3 |
| | | NS | 21.0 | 26.6 |
| 3—Exact | Heavy pressure required | S | 43.0 | 48.6 |
| | | SS | 46.5 | 52.1 |
| | | NS | 47.8 | 53.4 |
| Supplementary Rule for Surface Alignment | | | | |
| P1SE per alignment: $>{}^1/_{16} \leqslant {}^1/_4''$ | | P2SE per alignment: $\leqslant {}^1/_{16}''$ | | |

*Distance moved to engage—1" or less.

# Release

- Release is the basic element to relinguish control of an object by the fingers or hand.
- Two classifications;
  - Normal release, simple opening of fingers
  - Contact release, release bgins and is completed at the instant the following reach begins

**Table 41.** Release—RL

| Case | Time TMU | Description |
|------|----------|-------------|
| 1 | 2.0 | Normal release performed by opening fingers as independent motion. |
| 2 | 0 | Contact Release |

## Disengage

Disengage is the basic element used to break contact between one object and another. It includes an involuntary movement resulting from the sudden ending of resistance. The time for disengage is affected by the following three variables: (1) class of fit, (2) ease of handling, and (3) care of handling (Table 42).

**Table 42.** Disengage—D

| Class of Fit | Height of Recoil | Easy to Handle | Difficult to Handle |
|--------------|------------------|----------------|---------------------|
| 1—Loose—Very slight effort, blends with subsequent move. | Up to 1" | 4.0 | 5.7 |
| 2—Close—Normal effort, slight recoil. | Over 1" to 5" | 7.5 | 11.8 |
| 3—Tight—Considerable effort, hand recoils markedly. | Over 5" to 12" | 22.9 | 34.7 |

# Eye Times

- In most work, time for moving and focusing the eye is not a limiting factor and consequently does not affect the time for the operation. When the eyes do direct the hands or body movements, however, eye times must be considered. There are two types of eye time;
  - Eye focus
  - Eye travel time

# Eye Times

- Eye focus time is the time required to focus the eyes on an object and look at it long enough to determine certain readily distinguishable characteristics within the area which may be seen without shifting the eyes.

- Eye travel time is affected by the distance between points from and to which the eye travels, and the perpendiculat distance from the eye to the line of travel

**Table 43.** Eye Travel and Eye Focus—ET and EF

Eye Travel Time $= 15.2 \times \dfrac{T}{D}$ TMU, with a maximum value of 20 TMU.

where T = the distance between points from and to which the eye travels.
D = the perpendicular distance from the eye to the line of travel T.

Eye Focus Time = 7.3 TMU.

Supplementary Information

—Area of Normal Vision = Circle 4″ in Diameter 16″ from Eyes
—Reading Formula = 5.05 N Where N = The Number of Words.

**Table 46.** Conventions for Recording MTM

| Table | Example | Significance |
|---|---|---|
| 35 | R8C | Reach, 8 inches, Case C |
| | R12Am | Reach, 12 inches, Case A, hand in motion at end. |
| 36 | M6A | Move, 6 inches, Case A, object weighs less than 2.5 pounds |
| | mM10C | Move, 10 inches, Case C, hand in motion at the beginning, object less than 2.5 pounds |
| | M16B15 | Move, 16 inches, Case B, object weighs 15 pounds |
| 37 | T30 | Turn hand empty 30 degrees |
| | T90L | Turn object weighing more than 10 pounds 90 degrees |
| 38 | APB | Apply pressure, includes regrasp |
| 39 | G1A | Grasp, Case G1A |
| 40 | P1NSD | Position, Class 1 fit, nonsymmetrical part, difficult to handle |
| 41 | RL1 | Release, Case 1 |
| 42 | D2E | Disengage, Class 2 fit, easy to handle |
| 43 | EF | Eye focus |
| | ET14/10 | Eye travel between points 14″ apart where line of travel is 10″ from eyes |

When these symbols are recorded, they are written down in such a way as to in-
dicate the hand making the motions, the sequence, and the time values.

| LH | TMU | RH |
|-----|------|------|
| R12C | 14.2 | |
| G4A | 7.3 | |
| M10A | 11.3 | |
| G3 | 5.6 | G3 |
| | 5.2 | M2C |
| | 5.6 | P1SE |
| | 2.0 | RL1 |
| Total | 51.2 | |

This indicates that the following motions take place. The left hand makes a 12-inch
Case C reach followed by a G4A to pick up an object. The left hand then moves the
object back to the other hand. A transfer grasp puts the object in the right hand,
which then moves it 2 inches to an exact location, positions it, and releases it.

EXAMPLE   The analysis shown in Fig. 234 includes the motions required in order to dispose
of one part and obtain the next in a given layout.
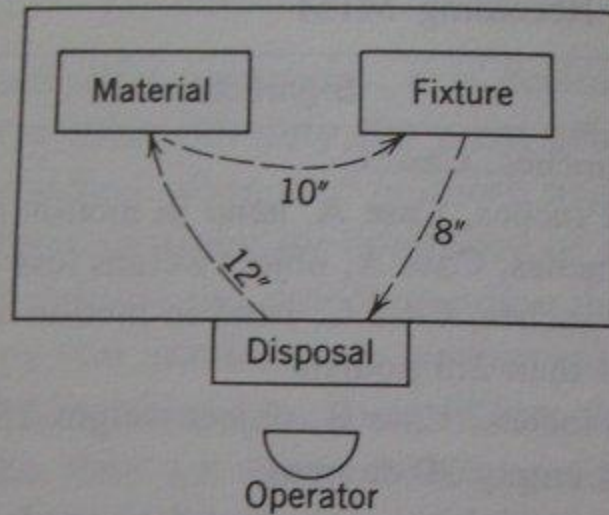
| | LH | TMU | RH |
|---|---|---|---|
| MOVE part 8 inches from fixture to disposal chute | | 10.6 | M8B |
| RELEASE part | | 2.0 | RL1 |
| REACH 12 inches to bin for next part | R12C | 14.2 | |
| GRASP part | G4B | 9.1 | |
| MOVE part 10 inches to fixture | M10C | 13.5 | |
| POSITION part in fixture | P2SE | 16.2 | |
| Total time | | 65.6 or 0.039 minute | |

**Figure 234**  Example of MTM analysis—dispose of one part and obtain the next. Machine operation time not shown.