FUNDAMENTAL HAND MOTIONS

IENG 301

FUNDAMENTALS OF WORK STUDY AND ERGONOMICS

Fundamental Hand Motions

- Most work is done with the two hands, and all manual work consists of a relatively few fundamental motions that are performed over and over again.

- Frank B. Gilbreth, in his early work in motion study, developed certain subdivisions or events which he thought common to all kinds of manual work. He coined the word ***therblig*** in order to have a short word with which to refer to any of these 17 elementary subdivisions of a cycle of motions. The experienced analyst has no difficulty in using these ***therbligs*** in industrial applications.

- Although the word therblig is familiar to industrial engineers, the term motion or hand motion is preferred when discussing the subject of micromotion study with factory and office personnel.

Definitions of Fundamental Hand Motions

1. **Search (Sh):** that part of the cycle during which the eyes or the hands are hunting or groping for the object. “Sh” begins when the eyes or hands begin to hunt for the object, and ends when the object has been found.

2. **Select (St):** the choice of one object from among several. In many cases it is difficult if not impossible to determine where the boundaries lie between search and select. For this reason it is often the practice to combine them, referring to both as the one *therblig* select. Then the broader definition of select refers to the hunting and locating of one object from among several. “St” begins when the eyes or hands begin to hunt for the object, and ends when the desired object has been located

Definitions of Fundamental Hand Motions

3. **Grasp (G):** taking hold of an object, closing the fingers around it preparatory to picking it up, holding it or manipulating it. "**G**" begins when the hand or fingers first make contact with the object, and ends when the hand has obtained control of it.

4. **Transport empty (TE):** moving the empty hand in reaching for an object. It is assumed that the hand moves without resistance toward or away from the object. "**TE**" begins when the hand begins to move without load or resistance, and ends when the hand stops moving.

Definitions of Fundamental Hand Motions

5. **Transport loaded (TL):** moving an object from one place to another. The object may be carried in the hands or fingers, or it may be moved from one place to another by sliding, dragging, or pushing it along. Transport loaded also refers to moving the empty hand against resistance. "**TL**" begins when the hand begins to move an object or encounter resistance, and ends when the hand stops moving.

6. **Hold (H):** retention of an object after it has been grasped, no movement of the object taking place. "**H**" begins when the movement of the object stops, and ends with the start of the next ***therblig***.

Definitions of Fundamental Hand Motions

7. **Release load (RL):** letting go of the object. "**RL**" begins when the object starts to leave the hand, and ends when the object has been completely separated from the hand or fingers.

8. **Position (P):** turning or locating an object in such a way that it will be properly oriented to fit into the location for which it is intended. It is possible to position an object during the motion transport loaded. "**P**" begins when the hand begins to turn or locate the object, and ends when the object has been placed in the desired position or location.

Definitions of Fundamental Hand Motions

9. **Pre-position (PP):** locating an object in a predetermined place, or locating it in the correct position for some subsequent motion. "**PP**" is the same as position except that the object is located in the approximate position that will be needed later.

10. **Inspect (I):** examining an object to determine whether or not it complies with standard size, shape, color, or other qualities previously determined. The inspection may employ sight, hearing, touch, odor, or taste. Inspect is predominantly a mental reaction and may occur simultaneously with other ***therblig***s. "**I**" begins when the eyes or other parts of the body begin to examine the object, and ends when the examination has been completed.

Definitions of Fundamental Hand Motions

11. **Assemble (A):** placing one object into or on another object with which it becomes an integral part. "**A**" begins as the hand starts to move the part into its place in the assembly, and ends when the hand has completed the assembly.

12. **Disassemble (DA):** separating one object from another object of which it is an integral part. "**DA**" begins when the hand starts to remove one part from the assembly, and ends when the hand has separated the part completely from the remainder of the assembly.

Definitions of Fundamental Hand Motions

13. **Use (U):** manipulating a tool, device, or piece of apparatus for the purpose for which it was intended. “U” begins when the hand starts to manipulate the tool or device, and ends when the hand ceases the application.

14. **Unavoidable delay (UD):** a delay beyond the control of the operator. “UD” may result from either of the following causes: (a) a failure or interruption in the process; (b) an arrangement of the operation that prevents one part of the body from working while other body members are busy. “UD” begins when the hand stops its activity, and ends when activity is resumed.

Definitions of Fundamental Hand Motions

15. **Avoidable delay (AD):** any delay of the operator for which he or she is responsible and over which he or she has control. It refers to delays, which the operator may avoid if desired. "**AD**" begins when the prescribed sequence of motions is interrupted, and ends when the standard work method is resumed.

16. **Plan (Pn):** a mental reaction, which precedes the physical movement that is, deciding how to proceed with the job. "**Pn**" begins at the point where the operator begins to work out the next step of the operation, and ends when the procedure to be followed has been determined.

Definitions of Fundamental Hand Motions

17. **Rest for overcoming fatigue (R):** a fatigue or delay factor or allowance provided to permit the worker to recover from the fatigue incurred by the work. "**R**" begins when the operator stops working, and ends when work is resumed.

Therbligs

Name of Symbol	Therblig Symbol		Explanation-suggested by	Color	Color Symbol	Dixon Pencil Number	Eagle Pencil Number
Search	Sh		Eye turned as if searching	Black		331	747
Select	St		Reaching for object	Gray, light		399	734½
Grasp	G		Hand open for grasping object	Lake red		369	744
Transport empty	TE		Empty hand	Olive green		391	739½
Transport loaded	TL		A hand with something in it	Green		375	738
Hold	H		Magnet holding iron bar	Gold ochre		388	736½
Release load	RL		Dropping content out of hand	Carmine red		370	745
Position	P		Object being placed by hand	Blue		376	741
Pre-position	PP		A nine-pin which is set up in a bowling alley	Sky-blue		394	740½
Inspect	I		Magnifying lens	Burnt ochre		398	745½
Assemble	A		Several things put together	Violet, heavy		377	742
Disassemble	DA		One part of an assembly removed	Violet, light		377	742
Use	U		Word "Use"	Purple		396	742½
Unavoidable delay	UD		Man bumping his nose, unintentionally	Yellow ochre		373	736
Avoidable delay	AD		Man lying down on job voluntarily	Lemon yellow		374	735
Plan	Pn		Man with his fingers at his brow thinking	Brown		378	746
Rest for overcoming fatigue	R		Man seated as if resting	Orange		372	737

Figure 79 Standard symbols and colors for fundamental hand motions.

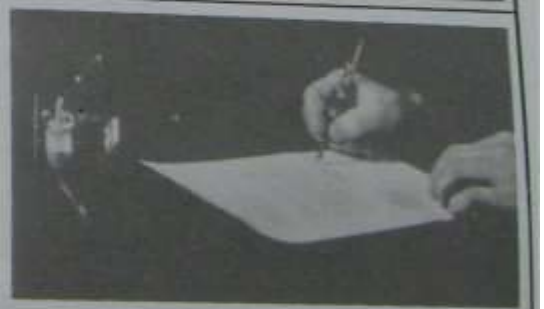
Signing a Letter - 1

	Name and Definition of Motion	Symbol	Description of Motion	Illustration
1	**TRANSPORT EMPTY** (Transport Empty refers to moving the empty hand in reaching for an object. It is assumed that the hand moves without resistance toward or away from the object. Transport empty begins when the hand begins to move without load or resistance and ends when the hand stops moving.)	TE	Reach for pen.	
2	**GRASP** (Grasp refers to taking hold of an object, closing the fingers around it preparatory to picking it up, holding it or manipulating it. Grasp begins when the hand or fingers first make contact with the object and ends when the hand has obtained control of it.)	G	Take hold of pen – close thumb and fingers around pen.	
3	**TRANSPORT LOADED** (Transport Loaded refers to moving an object from one place to another. The object may be carried in the hands or fingers or it may be moved from one place to another by sliding, dragging, or pushing it along. Transport loaded also refers to moving the empty hand against resistance. Transport loaded begins when the hand begins to move an object or encounter resistance and ends when the hand stops moving.)	TL	Carry pen to paper.	

(Continued)

Figure 80 Fundamental hand motions of the right hand in signing a letter.

Signing a Letter - 2

	Name and Definition of Motion	Symbol	Description of Motion	Illustration
4	**POSITION** (Position consists of turning or locating an object in such a way that it will be properly oriented to fit into the location for which it is intended. It is possible to position an object during the motion transport loaded. The carpenter, for examole, may turn the nail into position for using while he is carrying it to the board into which it will be driven. Position begins when the hand begins to turn or locate the object and ends when the object has been placed in the desired position or location.)	P	Position pen on paper for writing.	
5	**USE** (Use consists of manipulating a tool, device, or piece of apparatus for the purpose for which it was intended. Use may refer to an almost infinite number of particular cases. It represents the motion for which preceding motions have been more or less preparatory and for which the ones that follow are supplementary. Use begins when the hand starts to manipulate the tool or device and ends when the hand ceases the application.)	U	Sign letter.	
6	**TRANSPORT LOADED**	TL	Return pen to holder.	

Signing a Letter - 3

	Name and Definition of Motion	Symbol	Description of Motion	Illustration
7	**PRE-POSITION** (Pre-position refers to locating an object in a predetermined place or locating it in the correct position for some subsequent motion. Pre-position is the same as position except that the object is located in the approximate position that it will be needed later. Usually a holder, bracket, or special container of some kind is used for holding the object in a way that permits it to be grasped easily in the position in which it will be used. Pre-position is the abbreviated term used for pre-position for the next operation.)	PP	Position pen in holder.	
8	**RELEASE LOAD** (Release Load refers to letting go of the object. Release load begins when the object starts to leave the hand and ends when the object has been completely separated from the hand or fingers.)	RL	Let go of pen.	
9	**TRANSPORT EMPTY**	TE	Move hand back to letter.	

Pin Board – Old Method

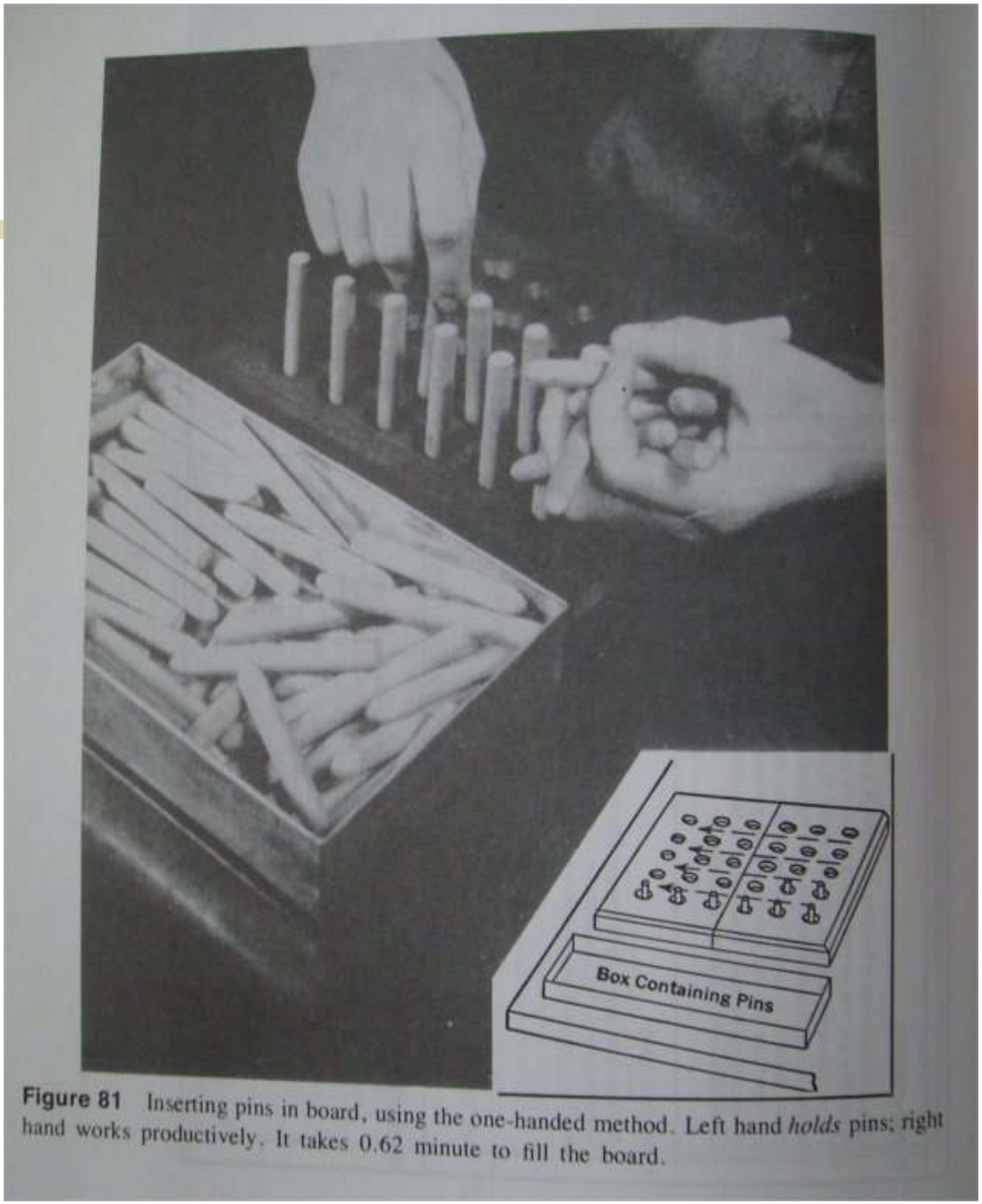


Figure 81 Inserting pins in board, using the one-handed method. Left hand *holds* pins; right hand works productively. It takes 0.62 minute to fill the board.

Pin Board – New Method

Figure 82 Inserting pins in board, using simultaneous motions, both hands working together. It takes only 0.41 minute to fill the board using this method.

Therbligs – Pin Board 1

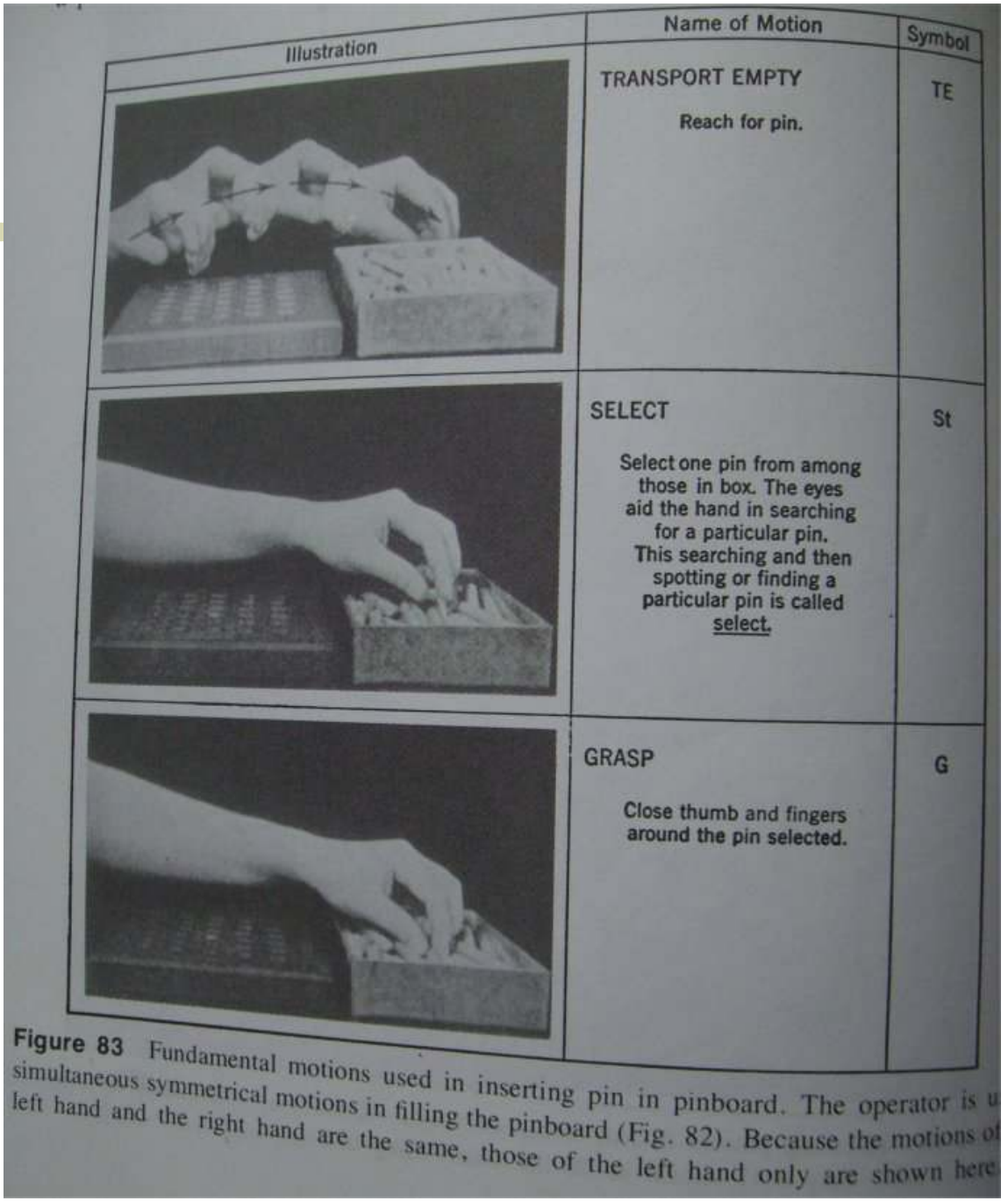
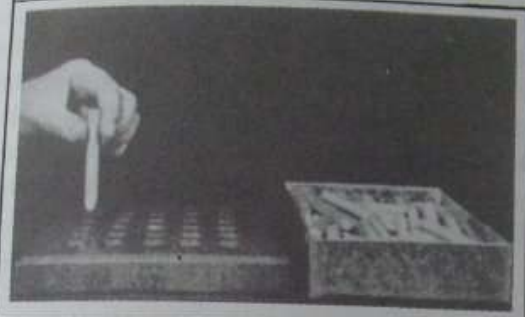
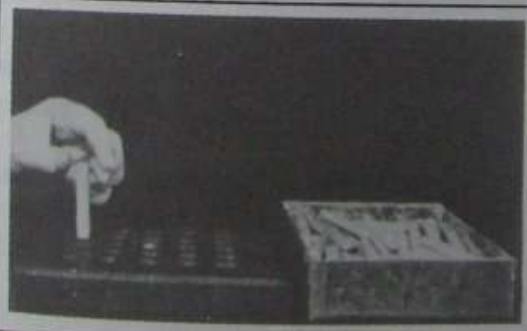


Illustration	Name of Motion	Symbol
	TRANSPORT EMPTY Reach for pin.	TE
	SELECT Select one pin from among those in box. The eyes aid the hand in searching for a particular pin. This searching and then spotting or finding a particular pin is called select.	St
	GRASP Close thumb and fingers around the pin selected.	G

Figure 83 Fundamental motions used in inserting pin in pinboard. The operator is u simultaneous symmetrical motions in filling the pinboard (Fig. 82). Because the motions of left hand and the right hand are the same, those of the left hand only are shown here

Therbligs – Pin Board 2

Illustration	Name of Motion	Symbol
	TRANSPORT LOADED Carry pin from tray to hole in board into which it will be inserted. Also: POSITION (in transit) Pin is turned into vertical position as it is transported to board.	TL P
	POSITION Pin is lined up directly over the hole in the board into which it is to be inserted.	P
	ASSEMBLE Insert pin into hole in board.	A
	RELEASE LOAD Open fingers – let go of pin.	RL

SIMO CHART

- The time for each therblig recorded on the analysis sheet may be shown to scale by means of a simultaneous-motion-cycle chart (simo chart).

  - Simo chart – Bolt & Washer assembly old method (P. 147)
  - Simo chart – Bolt & Washer assembly new method (P. 148)