

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
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.
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*.
 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.
 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 *therbligs*. “**I**” begins when the eyes or other parts of the body begin to examine the object, and ends when the examination has been completed.
 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.
 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.

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.
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.

MICROMOTION STUDY

Micromotion study provides a technique for recording and timing an activity. It consists of taking motion pictures of the operation with a clock in the picture or with a motion picture camera or video camera operating at a constant and known speed. The film becomes a permanent record of both method and time and may be re-examined whenever desired.

Purposes of Micromotion Study

1. As an aid in studying the activities of two or more persons on group work,
2. As an aid in studying the relationship of the activities of the operator and the machine,
3. As a means of timing operations (instead of time study),
4. As an aid in obtaining motion-time data for time standards,
5. As a permanent record of the method and time of activities of the operator and the machine,
6. For research in the field of motion and time study.

However, its two most important uses are:

1. To assist in finding the preferred method of doing work,
2. To assist in training individuals to understand the meaning of motion study and, when the training is carried out with sufficient thoroughness, to enable them to become proficient in applying motion economy principles.

Micromotion Study as an Aid in Improving Methods

The procedure consists of:

- 1)- filming the operation to be studied,
- 2)- analyzing the film,
- 3)- charting the results of the analysis, and
- 4)- developing an improved method through the problem-solving process.

Micromotion study, although not prohibitive in cost, does require special motion picture equipment, film, and considerable time for the analysis. Therefore, it can be used when it is **economical** to do so. It might profitably be utilized in the investigation of short-cycle operations that are highly repetitive or largely manual in character, of work produced in large volume, or of operations performed by large numbers of workers. In fact, a micromotion study is often the last resort. Sometimes in a complex operation it is difficult to get the motions of the two hands balanced without the aid of the SIMO chart, which is a graphic picture of the motions on paper.

SIMO chart is an operation chart which uses THERBLIGS in describing the motions of the hands.

Signing a letter (SIMO Chart Example):










Name and Definition of Motion	Symbol	Description of Motion	Illustration
<p>1 TRANSPORT EMPTY</p> <p>(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.)</p>	TE	Reach for pen.	
<p>2 GRASP</p> <p>(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.)</p>	G	Take hold of pen - close thumb and fingers around pen.	
<p>3 TRANSPORT LOADED</p> <p>(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.)</p>	TL	Carry pen to paper.	

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

(Continued)

Name and Definition of Motion	Symbol	Description of Motion	Illustration
<p>4 POSITION</p> <p>(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 example, 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>	P	Position pen on paper for writing.	
<p>5 USE</p> <p>(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.)</p>	U	Sign letter.	
<p>6 TRANSPORT LOADED</p>	TL	Return pen to holder.	

Name and Definition of Motion	Symbol	Description of Motion	Illustration
<p>7 PRE - POSITION</p> <p>(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.)</p>	PP	Position pen in holder.	
<p>8 RELEASE LOAD</p> <p>(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.)</p>	RL	Let go of pen.	
<p>9 TRANSPORT EMPTY</p>	TE	Move hand back to letter.	

Filling a Pin board (SIMO Chart Example):

If both hands were to work simultaneously at getting and placing the pins in the holes, the operator's efforts would be much more effective. We are now applying one of the "principles of motion economy" which will be presented later. We are having a preview of one of these principles now.




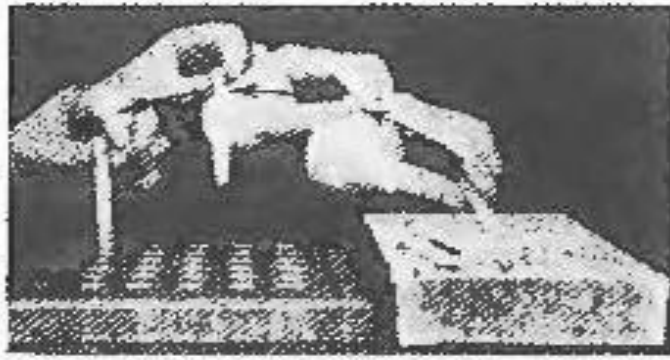



Illustration	Name of Motion	Symbol
	<p>TRANSPORT EMPTY</p> <p>Reach for pin.</p>	<p>TE</p>
	<p>SELECT</p> <p>Select one pin from among those in box. The eyes aid the hand in searching for a particular pin. This searching and then spotting or finding a particular pin is called <u>select</u>.</p>	<p>St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

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

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

PRINCIPLES OF MOTION ECONOMY

As Related To The Use Of The Human Body

1. The two hands should begin as well as complete their motions at the same time.
2. The two hands should not be idle at the same time except during rest periods.
3. Motions of the arms should be made in opposite and symmetrical directions, and should be made simultaneously.
4. Hand and body motions should be confined to the lowest classification with which it is possible to perform the work satisfactorily.
5. Momentum should be employed to assist the worker whenever possible, and it should be reduced to a minimum if it must be overcome by muscular effort.
6. Smooth continuous curved motions of the hands are preferable to straight-line motions involving sudden and sharp changes in direction.
7. Ballistic movements are faster, easier, and more accurate than restricted (fixation) or “controlled” movements.
8. Work should be arranged to permit easy and natural rhythm wherever possible.
9. Eye fixations should be as few and as close together as possible.

As Related To The Work Place

10. There should be a definite and fixed place for all tools and materials.
11. Tools, materials, and controls should be located close to the point of use.
12. Gravity feed bins and containers should be used to deliver material close to the point of use.
13. Drop deliveries should be used whenever possible.
14. Materials and tools should be located to permit the best sequence of motions.
15. Provision should be made for adequate conditions for seeing. Good illumination is the first requirement for satisfactory visual perception.
16. The height of the work place and the chair should preferably be arranged so that alternate sitting and standing at work are easily possible.
17. A chair of the type and height to permit good posture should be provided for every worker.

As Related To The Design Of Tools And Equipment

18. The hands should be relieved of all work that can be done more advantageously by a jig, a fixture, or a foot-operated device.
19. Two or more tools should be combined wherever possible.
20. Tools and materials should be pre-positioned whenever possible.
21. Where each finger performs some specific movement, such as in typewriting, the load should be distributed in accordance with the inherent capacities of the fingers.
22. Levers, hand wheels and other controls should be located in such positions that the operator can manipulate them with the least change in body position and with the greatest speed and ease.