



## Basic movements of body parts in the sewing machine operations

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### KEYWORDS :

#### 1. Introduction:

In the early 19th century, Frederick Taylor pioneered the scientific management method, which proposed a way to find the optimum method of carrying out a given task. Frank and Lillian Gilbreth expanded Taylor's methods to develop the time and motion study (Theresa Stack, 2016). They aimed to improve efficiency by eliminating unnecessary steps and actions. The principles of motion economy developed by Frank & Lillian Gilbreth in 1923 and subsequently elaborated by Mogensen, Ralph Barnes, David Porter and other researchers, have many principles concerning the economy of movements of the human body (Morrow, 1946). Out of various repeated physical motions, it is need of the hour to determine the correct and efficient motion pattern to perform a given task. These principles are grouped into three categories human body movements, best layout of workplaces and optimum design of equipment and tools. Further, the human body areas which apply to actual human motions are classified into five categories as mentioned in the table below. They are arranged to such that the first one gives least fatigue and is most economical.

Class	Pivot	Body parts moved
1	Knuckle	Fingers
2	Wrist	Hand + above
3	Elbow	Forearm + above
4	Shoulder	Upper arm + above
5	Trunk	Torso + above

**Table 1- Classification of Body Movements (Sakamoto, 2010)**

One or more of these anatomical parts are moved to execute the work cycle. The physical requirements needed to execute sewing operation movements are measured regarding the range and type of body motion. An operator's hand is of little value if it cannot perform the necessary actions for efficient sewing.

The basic body movements in sewing machine operations are explained as Flexion, extension, abduction, and adduction. Flexion is the motion of bending a limb while an extension is the reciprocal movement which straightens the limb. Abduction is a movement which draws the limb away from its center line, whereas adduction, the opposite of abduction, draws the limb toward its middle line and a rotating limb turns on its axis. The types of ranges of rotation used for a sewing operation will vary with the individual's physical capacities, the fabric quality, the machine bed and table, the machine speed and geometric form of operation (Solinger, 1968).

#### 2. Experimental Research:

The study is conducted to understand the relationship between basic motions with body joints in the basic sewing machine operations. For the same the basic motions - flexion, extension, abduction, adduction, and rotating limb have been considered in X-axis of and the body joints in upper limb i.e. shoulder, elbow, wrist, finger, and thumb is taken into Y-axis of the table.

Movements of body parts in sewing machine operations					
Body Joints	Basic Motions				
	Flexion	Extension	Abduction	Adduction	Rotating limb
Shoulder (SI)	√	√	√	√	√
Elbow (EI)	√	√	√		
Wrist (Wr)	√	√			
Finger (Fi)	√	√			
Thumb (Th)	√	√	√	√	

**Table 2- Relation between basic motions with body joints**

Out of these upper torso motions mentioned above, flexion and extension motions have common presence in basic sewing operations. Other motions abduction, adduction, rotating limb and limb circumference occurs during shoulder movement while in thumb movements, abduction and adduction take place along with flexion and extension. Elbow, wrist, and finger have only flexion and extension.

After establishing the relationship between basic motions with body joints, the next stage is to find out the common presence of body parts among different sewing operations with the relation between 5 elements- picking, align, stitch, re-align, re-stitch and dispose of. The six different sewing machine operations with different skill sets and machine bed types have been selected. These six sewing operations are-

- Side seam join operation of full sleeve formal shirt using Feed-off-the-arm (FOA) machine
- Inseam join operation of denim pant using Feed-off-the-arm (FOA) machine
- Bottom hem operation of denim pant using cylindrical bed machine
- Bottom hem operation of t-shirts using raised bed machine
- Elastic waistband operation in elasticated pajama with elastic waistband using raised bed (Kansai Special) machine.
- Round Elastic waistband attaching using Cylindrical Bed Machine

All these six sewing machine operations have been selected to cover the various types of body movements across different product categories.

Side Seam join Operation of Full Sleeve Formal Shirt using Feed-off-the-arm (FOA) Machine					
Name of the Elements	Motions				
	Flexion	Extension	Abduction	Adduction	Rotating limb

<b>Picking</b>	Th, Fi, El	Th, Fi, El	Th, Sl	Th, Sl	Sl
<b>Align</b>	Th, Fi, Wr, Sl	Th, Fi, Wr, Sl	-	-	-
<b>Stitch</b>	Th, Fi, Wr, Sl	Th, Fi, Wr, El	-	-	-
<b>Re-align</b>	Th, Fi, Wr, Sl	-	-	-	-
<b>Re-stitch</b>	Th, Fi, Wr, Sl	Th, Fi, Wr, El	-	-	-
<b>Dispose</b>	-	-	Th, Sl		Sl
<b>Inseam Operation of Denim Pant using Feed-off-the-arm (FOA) Machine</b>					
<b>Name of the Elements</b>	<b>Motions</b>				
	Flexion	Extension	Abduction	Adduction	Rotating limb
<b>Picking</b>	Th, Fi, El	Th, Fi, El	Th, Sl	Th, Sl	Sl
<b>Align</b>	Th, Fi, Wr, Sl	Th, Fi, Wr, Sl	-	-	-
<b>Stitch</b>	Th, Fi, Wr, Sl	Th, Fi, Wr, El	-	-	-
<b>Dispose</b>	-	-	Th, Sl		Sl
<b>Bottom Hem Operation of Denim Pant using Cylindrical Bed Machine</b>					
<b>Name of the Elements</b>	<b>Motions</b>				
	Flexion	Extension	Abduction	Adduction	Rotating limb
<b>Picking</b>	Th, Fi, El	-	Th, Sl	Th, Sl	-
<b>Align</b>	Wr	-	-	-	-
<b>Stitch</b>	Th, Fi, Wr, Sl	Th, Fi, Wr, El	-	-	Wr
<b>Dispose</b>	-	-	-	-	Sl
<b>Bottom Hem Operation of T-shirts using Raised Bed Machine</b>					
<b>Name of the Elements</b>	<b>Motions</b>				
	Flexion	Extension	Abduction	Adduction	Rotating limb
<b>Picking</b>	Th, Fi, El	-	Th, Sl	Th, Sl	
<b>Align</b>	Wr	-	-	-	-
<b>Stitch</b>	Th, Fi, Wr, Sl	Th, Fi, Wr, El	-	-	-
<b>Dispose</b>	-	-	-	-	Sl
<b>Elastic Waistband Operation in Elasticated Pajama using Raised Bed (Kansai special type) Machine</b>					
<b>Name of the Elements</b>	<b>Motions</b>				
	Flexion	Extension	Abduction	Adduction	Rotating limb
<b>Picking</b>	Sl, El	Sl, El	-	-	-
<b>Align</b>	Th, Fi, Sl	-	-	-	-
<b>Stitch</b>	Th, Fi, Wr, Sl	Th, Fi, Wr, El	-	-	-
<b>Dispose</b>	-	-	-	-	Sl
<b>Round Elastic waistband attaching using Cylindrical Bed Machine</b>					
<b>Name of the Elements</b>	<b>Motions</b>				
	Flexion	Extension	Abduction	Adduction	Rotating limb
<b>Picking</b>	Sl, El	Sl, El	-	-	-
<b>Align</b>	Wr	-	-	-	-
<b>Stitch</b>	Th, Fi, Wr, Sl	Th, Fi, Wr, El	-	-	Wr
<b>Dispose</b>	-	-	-	-	Sl

**Table 3- Relation between basic motions with elements in sewing machine operations**

Table 3 shows the relation between basic motions vs. five elements-picking, align, stitch, re-align, re-stitch and dispose with respect to body part joints i.e shoulder (Sl), Elbow (El), Wrist (Wr), Finger (Fi) and Thumb (Th). In the first case i.e. the side seam operation of shirt using Feed-off-the-arm machine, the flexion and extension have maximum presence. Second case is for inseam of jeans using Feed-off-the-arm machine, which also says the maximum presence of flexion and extension motions. Next one shows the sewing operation for bottom hemming of jeans where flexion has major presence. Similarly in other operations- 'Bottom hemming of T-shirts using Raised bed machine', 'Elastic waistband attaching using Raised bed (Kansai special type)' and 'Round elastic waistband attaching using cylindrical bed' major motion is flexion.

**3. Findings**

The above analysis shows the importance of the body movements such as flexion, extension, abduction, adduction, rotating limb in performing different sewing tasks. Unfortunately, none of the training programs, being imparted in the garment industry, talks about these utmost important human body movements. Also, the presence of these important body movements found missing during the method study and motion analysis in the sewing machine operations. These body movements should be taken into consideration during method analysis and developing a training program from an ergonomics point of view to reduce fatigue and other occupational hazards in the sewing floor keeping focus on the repetitive occurrence of flexion motion.

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