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Increasing Efficiency by Method Improvement Using Time Study and Two Hand Motion Study

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ABSTRACT
Bottlenecks in any manufacturing unit are the main causes of reduced efficiency and productivity. Bottleneck can be caused by improper method of performing a particular operation, machinery condition and unnecessary non-value-added time. The major cause of bottleneck in a labor-intensive manufacturing unit is the improper method of performing a operation. Operators create a lot of non-value-added time because of stoppages or preparing for a start-up before actually performing the operation. Sewing a particular part is a sort of start-stop process, where the operator has to frequently start and stop the sewing machine. So, every time the sewing is started, the operator takes some time preparing for the operation, commonly known as burst, which is one of main reasons of non-value-added time. In order to reduce this, time study and motion study are two of the most important and easy to implement tools for improving the efficiency, productivity and method of working. In the present study, time study and motion study were performed on a jacket sewing line and after analyzing the results method improvements were implemented which led to an increase in the productivity of the operators at zero cost.

Keywords – Bottleneck, method improvement, motion study, non-value-added time, productivity, time study.

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I. INTRODUCTION

Achieving maximum productivity and efficiency is a cut throat task when it comes to running an industry with more human efforts as well as machines. Considering the number of workers in the garment industry, the men to machine ratio is almost the same. This leads to more requirement of precise management and analysis of human efforts and their varying efficiency.

As the skills and experience differs from operator to operator, it becomes extremely important to initiate a detailed study of each and every person, as in the case of mass production, every second, every minute and every effort counts and has a cumulative effect on the production.

Although the workers in the industry are conditioned to work with their maximum efficiency, the results obtained are somehow lower than the desired outcome. Having an appropriate data about the knowhow of the operators is inevitable, which leads to conducting a pinpoint analysis.

In most apparel manufacturing units, the authorities face a major issue about the absenteeism of the operators. Due to the lack of appropriate data, finding the bottleneck of the lines and other issues gets difficult

Since the desired output cannot be obtained, it becomes very crucial to analyze and comprehend the factors affecting the production. The blockages causing the decrease in the production needs to be identified as soon as possible, for ensuring quick and hassle-free outcome.

Time study deals with the noting down of the amount of time taken by an operator, to completely finish one particular operation. It is performed to know the time taken by operator and then compare it with the SAM (Standard Allowed Minutes) of the operator.

If the operator finishes the task within the SAM of the operation, then the operator is doing the task with his maximum efficiency. If the operator exceeds SAM of the operation, then he is performing it with low efficiency. The skill level of the operator for a particular operation can be obtained from this study. Also, with the help of time study, the entire Skill Matrix board can be developed.

Hand motion study on other hand deeply observes the motion of the hands of the operators when they are doing their task. Both the hands are observed one by one from the starting of the operation till the end. It is a very detailed study, as it requires very keen eye of the observer on the operator's hands. It contains marking of the movements of the hand during each and every second. It contains categories like Operation, Transport, Inspect, Hold and Delay. So, every movement is allotted into their respective categories and a diagram is formed.

The major objectives of the present study are:

- To do the elemental breakdown of every operator, by segregating the method of operation into Pick, Align, Sew and Dispose.
- To deduce the exact spot in the method where the operator takes more time than allotted.
- To come up with strategies of reducing the time taken by the operator for doing the task by providing alternate ways.
- To develop skill matrix on the basis of the results obtained in this study.

Performing the time study and hand motion study provides a thorough insight of the operations, operators, machines, line balancing and so much more. It gives a brief knowledge and understanding about the structure of the process flow on the production floor.

II. METHODOLOGY

2.1 Operation breakdown

The operations are written in a sequence of actual process flow to be followed while making the garment in the shop floor. The method of preparing operations' list in a sequence is called as operation breakdown. The sheet of listed operations of a style is also known as operation breakdown.

An operation breakdown includes information like:

- Sewing and non-sewing operations
- Name of the machines to use for doing the specific operations
- Estimated time to do each operation for one unit

2.2 Time study with elemental breakdown

Steps in making time study:

- Select the work to be studied.
- Obtain and record all the information available about the job, the operator and the working conditions likely to affect the time study work.
- Breakdown the operation into elements. An element is an instinct part of a specified activity composed of one or more fundamental motions selected for convenience of observation and timing.
- Measure the time by means of a stop watch taken by the operator to perform each element of the operation. Either continuous method or snap back method of timing could be used.
- Add the suitable allowances to compensate for fatigue, personal needs, contingencies etc. to give standard time for each element.
- Compute allowed time for the entire job by adding elemental standard times considering frequency of occurrence of each element.
- Make a detailed job description describing the method for which the standard time is established.
- Test and review standards wherever necessary.

2.3 Identifying bottleneck

The lowest output point in production line is called bottleneck. The bottleneck area is where supply gathered and production goes under capacity. In the chain working systems the supply of an operator is the feeding of next operator. So, the minimum supply from bottleneck point will be the feeding of next operator as well as the production will not be more than the output of bottleneck point.

III. DATA ANALYSIS

3.1 Bottleneck analysis

Bottleneck analysis was done for front section of the jacket manufacturing line. The result obtained from the bottleneck analysis is shown in the below graph.

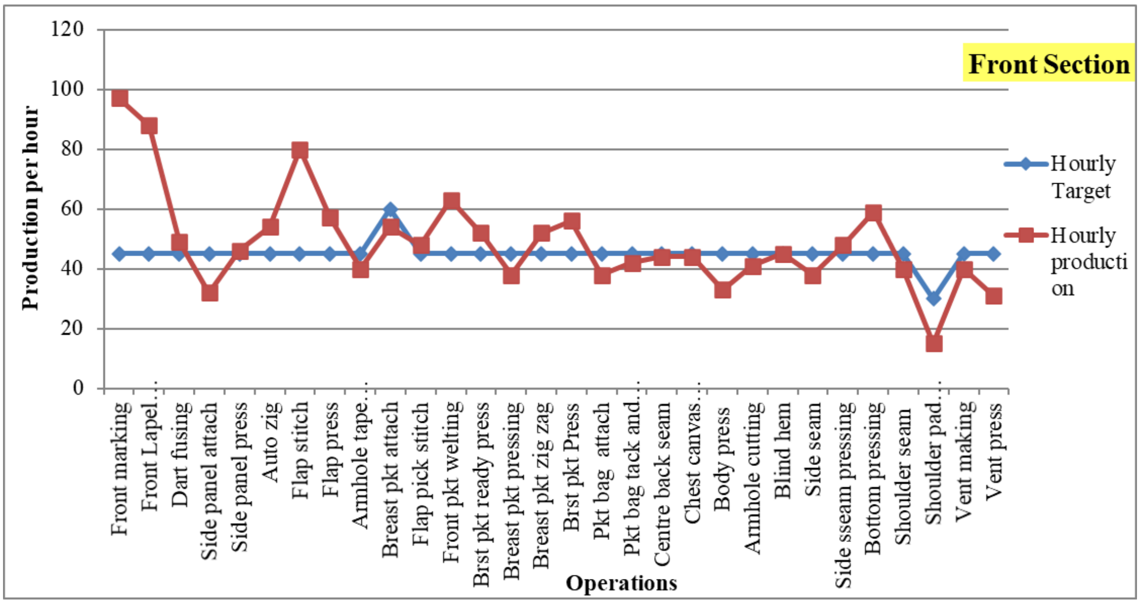
In the front section, following operations were considered as bottleneck operations:

- Side panel attach
- Armhole tape attach
- Centre back seam
- Side seam

These operations were considered as bottleneck because there was a wide gap between the target set and the actual production. The difference between the target and actual production for side panel attach was 13, armhole tape attach was 5 and side seam was 7, as shown in graph 1.

3.2 Hand motion study and method improvement

The following section shows the results obtained before and after the implementation of method improvement. For all the three operations, hand motion study and method improvement were done.



Graph 1: Comparison of target and actual production per hour

3.2.1 Side panel attach

For side panel attach, before implementing method improvement, the SAM was 1.45 and the production per hour was 32. Table 1 and 2 show the results obtained before implementing method improvement.

Table 1: Time study of side panel attach (before)

	Pick (s)	Align (s)	Sew (s)	Dispose (s)	Cycle time (s)	Avg. cycle time (min)
1	8.93	23.79	33.91	5.88	72.51	1.22
2	11.67	23.94	32.64	5.59	73.84	
3	8.31	26.48	37.11	3.05	74.95	
4	9.7	27.1	31.36	3.05	71.21	
5	10.25	26.16	34.38	3.04	73.83	

As shown in table 2, the results obtained from the two-hand motion study of the existing situation showed that there was a lot of non-value added (NVA) time which can be reduced and converted to value added (VA) time. The time taken for the initial burst was more, which is an unnecessary NVA.

The operators were suggested to reduce or eliminate the initial burst before starting the sewing machine. After implementing the changes, the results showed that the SAM reduced to 1.35 and the production per hour improved to 34. The cycle time for the operation reduced from 1.22 min to 1.12 min. This is evident from table 3 and table 4.

Table 3: Time study of side panel attach (after)

	Pick (s)	Align (s)	Sew (s)	Dispose (s)	Cycle time (s)	Avg. cycle time (min)
1	8.93	23.79	28.74	5.88	67	1.12
2	11.67	23.94	27.32	5.59	68.52	
3	8.31	26.48	29.01	3.05	66.94	
4	9.7	27.1	28.46	3.05	68.31	
5	10.25	26.16	28.38	3.04	67.83	

3.2.2 Armhole tape attach

For armhole tape attach operation, the SAM was 0.57 and production per hour was 40 before method improvement. Table 5 and 6 show the results obtained before implementing method improvement.

Table 5: Time study of armhole tape attach (before)

	Pick (s)	Align (s)	Sew (s)	Dispose (s)	Cycle time (s)	Avg. cycle time (min)
1	1.08	6.34	18.46	2.35	28.23	0.48
2	1.33	7.12	16.63	2.36	27.44	
3	1.56	9.03	19.13	2.03	31.75	
4	1.46	9.23	12.92	2.53	26.14	

5	1.33	8.54	14.42	1.55	25.84	

Table 2: Motion study of side panel attach (before)

Sr. No.	Left-hand description	○	⇨	□	D	△	VA/ NVA/ NNVA	VA/ NVA/ NNVA	○	⇨	□	D	△	Right-hand description
1	Pick 1st panel		●				NNVA	NNVA					●	Hold panel
2	Delay				●		NVA	NVA				●		Delay
3	Pick 2nd panel		●				NNVA	NNVA		●				Pickup 2nd panel
4	Put 2nd panel on m/c bed		●				NNVA	NNVA		●				Align panels
5	Delay				●		NVA	NVA				●		Delay
6	Align panels		●				NNVA	NNVA					●	Hold panels
7	Align under pressure foot		●				NNVA	NNVA		●				Align under pressure foot
8	Sew	●					VA	VA	●					Sew
9	Burst				●		NVA	NVA				●		Burst
10	Sew	●					VA	VA	●					Sew
11	Burst				●		NVA	NVA				●		Burst
12	Sew	●					VA	VA	●					Sew
13	Burst				●		NVA	NVA				●		Burst
14	Sew	●					VA	VA	●					Sew
15	Move panel		●				NNVA	NNVA		●				Dispose
16	Hold					●	NNVA							

Table 4: Motion study of side panel attach (after)

Sr. No.	Left-hand description	○	⇨	□	D	△	VA/ NVA/ NNVA	VA/ NVA/ NNVA	○	⇨	□	D	△	Right-hand description
1	Pick 1st panel		●				NNVA	NNVA					●	Hold panel
2	Delay				●		NVA	NVA				●		Delay
3	Pick 2nd panel		●				NNVA	NNVA		●				Pick 2nd panel
4	Put 2nd panel on m/c bed		●				NNVA	NNVA		●				Align panel
5	Delay				●		NVA	NVA				●		Delay
6	Align panels		●				NNVA	NNVA					●	Hold 2nd panel
7	Align under pressure foot		●				NNVA	NNVA		●				Align under pressure foot
8	Sew	●					VA	VA	●					Sew
9	Burst				●		NVA	NVA				●		Burst
10	Sew	●					VA	VA	●					Sew
11	Move panel		●				NNVA	NNVA		●				Dispose
12	Hold					●	NNVA							

As shown in table 6, the results obtained from the two-hand motion study of the existing situation showed that there was a lot of non-value added (NVA) time which can be reduced and converted to value added (VA) time. The time taken for the initial burst was more, which is an unnecessary NVA.

Again the operators were suggested to reduce or eliminate the initial burst before starting the sewing machine. After implementing the changes, the results showed that the SAM reduced to 0.50

Table 7: Time study of side panel attach (after)

	Pick (s)	**Align (s)**	**Sew (s)**	**Dispose (s)**	**Cycle time (s)**	**Avg. cycle time (min)**
1	1.91	5.05	15.86	3.94	27.88	0.42
2	2.01	5.12	15.21	2.56	24.9	
3	1.75	5.00	15.03	2.33	24.11	
4	1.84	5.09	15.92	2.53	25.38	
5	1.96	4.96	15.14	2.55	24.55	

and the production per hour improved to 48. The cycle time for the operation reduced from 0.48 min to 0.42 min. This is evident from table 7 and table 8.

Table 6: Motion study of armhole tape attach (before)

Sr. No.	Left-hand description	○	⇨	□	D	△	VA/ NVA/ NNVA	VA/ NVA/ NNVA	○	⇨	□	D	△	Right-hand description
1	Pick panel		●				NNVA	NNVA		●				Pick panel
2	Hold					●	NNVA	NNVA		●				Align
3	Align under pressure foot		●				NNVA	NNVA		●				Align under pressure foot
4	Sew	●					VA	VA	●					Sew
5	Burst				●		NVA	NVA				●		Burst
6	Sew	●					VA	VA	●					Sew
7	Burst				●		NVA	NVA				●		Burst
8	Sew	●					VA	VA	●					Sew
9	Burst				●		NVA	NVA				●		Burst
10	Sew	●					VA	VA	●					Sew
11	Burst				●		NVA	NVA				●		Burst
12	Sew	●					VA	VA	●					Sew
13	Dispose		●				NNVA	NNVA		●				Dispose

Table 8: Motion study of armhole tape attach (after)

Sr. No.	Left-hand description	○	⇨	□	D	△	VA/ NVA/ NNVA	VA/ NVA/ NNVA	○	⇨	□	D	△	Right-hand description
1	Pick panel		●				NNVA	NNVA		●				Pick panel
2	Hold					●	NNVA	NNVA		●				Align
3	Align under pressure foot		●				NNVA	NNVA		●				Align under pressure foot
4	Sew	●					VA	VA	●					Sew
5	Burst				●		NVA	NVA				●		Burst
6	Sew	●					VA	VA	●					Sew
7	Burst				●		NVA	NVA				●		Burst
8	Sew	●					VA	VA	●					Sew
9	Dispose		●				NNVA	NNVA		●				Dispose

3.2.3 Side seam

For side seam, before implementing method improvement, the SAM was 1.23 and the production per hour was 38. Table 9 and 10 show the results obtained before implementing method improvement.

Table 9: Time study of side seam (before)

	Pick (s)	**Align (s)**	**Sew (s)**	**Dispose (s)**	**Cycle time (s)**	**Avg. cycle time (min)**
1	3.28	14.82	41.33	1.41	60.84	1.038
2	2.81	15.84	42.67	1.23	62.55	
3	2.53	16.3	43.11	1.01	62.95	

4	3.47	15.45	41.45	1.09	62.36	
5	3.25	14.97	43.41	1.23	62.86	

Table 3: Time study of side seam (after)

	Pick (s)	**Align (s)**	**Sew (s)**	**Dispose (s)**	**Cycle time (s)**	**Avg. cycle time (min)**
1	8.93	23.79	28.74	5.88	67	
2	11.67	23.94	27.32	5.59	68.52	
3	8.31	26.48	29.01	3.05	66.94	1.12
4	9.7	27.1	28.46	3.05	68.31	
5	10.25	26.16	28.38	3.04	67.83	

As shown in table 10, the results obtained from the two-hand motion study of the existing situation showed that there was a lot of non-value added (NVA) time which can be reduced and converted to value added (VA) time. The time taken for the initial burst was more, which is an unnecessary NVA.

The operators were suggested to reduce or eliminate the initial burst before starting the sewing machine. After implementing the changes, the results showed that the SAM reduced to 1.2 and the production per hour improved to 40. The cycle time for the operation reduced from 1.038 min to 1 min. This is evident from table 11 and table 12.

Table 10: Motion study of side seam (before)

Sr. No.	Left-hand description	○	⇨	□	D	△	VA/ NVA/ NNVA	VA/ NVA/ NNVA	○	⇨	□	D	△	Right-hand description
1	Pick panel		●				NNVA	NNVA		●				Pick panel
2	Align panel		●				NNVA	NNVA		●				Align panel
3	Match checks on edges		●				NNVA	NNVA		●				Match checks on edges
4	Keep panel under pressure foot		●				NNVA	NNVA		●				Keep panel under pressure foot
5	Sew	●					VA	VA	●					Sew
6	Rotate panel		●				NNVA	NNVA		●				Rotate panel
7	Match checkes on the edges		●				NNVA	NNVA		●				Match checks on the edges
8	Sew	●					VA	VA	●					Sew
9	Burst				●		NVA	NVA				●		Burst
10	Sew	●					VA	VA	●					Sew
11	Burst				●		NVA	NVA				●		Burst
12	Sew	●					VA	VA	●					Sew
13	Burst				●		NVA	NVA				●		Burst
14	Sew	●					VA	VA	●					Sew
15	Burst				●		NVA	NVA				●		Burst
16	Sew	●					VA	VA	●					Sew
17	Burst				●		NVA	NVA				●		Burst
18	Sew	●					VA	VA	●					Sew
19	Burst				●		NVA	NVA				●		Burst
20	Sew	●					VA	VA	●					Sew
21	Rotate panel		●				NNVA	NNVA		●				Rotate panel
22	Match checks on edges		●				NNVA	NNVA		●				Match checks on edges
23	Keep Panel under pressure foot		●				NNVA	NNVA		●				Keep Panel under pressure foot
24	Sew	●					VA	VA	●					Sew
25	Burst				●		NVA	NVA				●		Burst
26	Sew	●					VA	VA	●					Sew
27	Burst				●		NVA	NVA				●		Burst

28	Sew	●					VA	VA	●					Sew
29	Burst				●		NVA	NVA				●		Burst
30	Sew	●					VA	VA	●					Sew
31	Burst				●		NVA	NVA				●		Burst
32	Sew	●					VA	VA	●					Sew
33	Burst				●		NVA	NVA				●		Burst
34	Sew	●					VA	VA	●					Sew
35	Burst				●		NVA	NVA				●		Burst
36	Sew	●					VA	VA	●					Sew
37	Rotate panel		●				NNVA	NNVA		●				Rotate panel
38	Sew	●					VA	VA	●					Sew
39	Flip the panel		●				NNVA	NNVA		●				Flip the panel
40	Inspect			●			VA	VA			●			Inspect
41	Dispose		●				NNVA	NNVA		●				Dispose

Table 12: Motion study of side seam (after)

Sr. No.	Left-hand description	○	⇨	□	D	△	VA/ NVA/ NNVA	VA/ NVA/ NNVA	○	⇨	□	D	△	Right-hand description
1	Pick panel		●				NNVA	NNVA		●				Pick panel
2	Align panel		●				NNVA	NNVA		●				Align panel
3	Match checks on edges		●				NNVA	NNVA		●				Match checks on edges
4	Keep panel under pressure foot		●				NNVA	NNVA		●				Keep panel under pressure foot
5	Sew	●					VA	VA	●					Sew
6	Rotate panel		●				NNVA	NNVA		●				Rotate panel
7	Match checks on the edges		●				NNVA	NNVA		●				Match checks on the edges
8	Sew	●					VA	VA	●					Sew
9	Burst				●		NVA	NVA				●		Burst
10	Sew	●					VA	VA	●					Sew
11	Burst				●		NVA	NVA				●		Burst
12	Sew	●					VA	VA	●					Sew
13	Burst				●		NVA	NVA				●		Burst
14	Sew	●					VA	VA	●					Sew
15	Rotate panel		●				NNVA	NNVA		●				Rotate panel
16	Match checks on the edges		●				NNVA	NNVA		●				Match checks on the edges
17	Keep the panel under pressure foot		●				NNVA	NNVA		●				Keep the panel under pressure foot
18	Sew	●					VA	VA	●					Sew
19	Burst				●		NVA	NVA				●		Burst
20	Sew	●					VA	VA	●					Sew
21	Burst				●		NVA	NVA				●		Burst
22	Sew	●					VA	VA	●					Sew
23	Burst				●		NVA	NVA				●		Burst
24	Sew	●					VA	VA	●					Sew
25	Rotate panel		●				NNVA	NNVA		●				Rotate panel
26	Sew	●					VA	VA	●					Sew
27	Flip the panel		●				NNVA	NNVA		●				Flip the panel
28	Inspect			●			VA	VA			●			Inspect

29	Dispose		●				NNVA	NNVA		●				Dispose

IV. CONCLUSION

The present study demonstrates that how SAM can be reduced with the help of hand motion study. Time study was taken with 5 observations of each operation in a jacket line. From the data of time study, SAM, production per hr and production per day was calculated. The study showed that there are few operators that performed operation taking more time. From those operations only bottle neck operations were taken in consideration for the study with the help of line manager. Two hand motion study was conducted on bottle neck operations to segregate value added, non-value added and necessary non-value-added hand motions performed by operators during an operation. This helped in removing non-value-added motion which was mostly burst time in sewing. With the help of floaters and team leaders, operators were trained in order to reduce burst time and remove non-value hand motion as well as to do improvised value-added motion. This helped in reducing SAM by 1.39 which increased production in jacket line by 38 pcs per hr.

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