

Productivity Improvement Through Time and Motion Method

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Abstract ---Economies of scales and scope approaches contributes towards the effective use of resource utilization which alternatively results in production enhancement, and improvement in economics indicators. Among various approaches to accomplish the concept of scale production, time and motions study plays a vital role to visualize and enhance the resource consumption and its economic value. In this paper, an implementation approach of time and motions mechanism is applied to track a manual task with the help of a kinematic model from images. The current method practiced in the industry is segregated according to different operations in the manufacturing setup and analyzed on the basis of charts, capturing frames of workers motions. At certain stages stopwatch technique is also used. The results of this research indicate that company's overall performance has significantly increased with the reduction in process duration.

Keywords: Manufacturing, Process analysis, Time study, Tracking human motion

I. INTRODUCTION

Time and motion study (TMS) assist management to determine how much is produced by workers in a specific period of time, therefore making it easier to predict work schedules and output. TMS became a necessary tool for businesses to be successful today. Both the manufacturing and service sectors utilizes its advantages. In this research time and motion study is applied in a manufacturing setup (i.e. a match production processes) which are highly repetitive. In repetitive tasks process time reduction and worker satisfaction and productivity are major concerns of management, as these tasks are boring, monotonous, fatiguing, de-motivating and consequently affect productivity and satisfaction (Shikdar and Das, 2003).

An extensive study has evolved over the years which is designed to enhance productivity of organizations and individuals making up the organizations. Design of methods and procedures and elimination of unnecessary tasks and are the most significant objectives of TMS (Barnes, 1980, Meyers and Stewart, 2002).

1.1 Problem Definition and Research Aim

International match factory private limited is one of the largest firms of safety match manufacturing firm in Khyber Pakhtunkhwa province of Pakistan. It started its production in 2001. They produce eight famous brands now a day's i.e., Alfa, Baba, Mat, Jugnoo etc. It produces daily five hundred cartons each containing five hundred match boxes i.e., two lac fifty thousand match box a day in ten-hour shift. The match is distributed country wide along with an export to middle and Far East. The simplest machine can process more than eight million match sticks each day and about four hundred and fifty cartons are packed, which contain approximately fifteen thousand and five hundred match sticks.

After continuous monitoring and brain storming with production manages and shift supervisors, it was investigated that:

1. There is no standard procedure for time study of any mechanism in two major sections of the industry.
2. There is no standard time for each packaging point and tray filling sections.
3. Regarding the first packaging point, after self-observation and investigation, it was found that this point uses more time in comparison with the others. The reasons for this must be investigated.
4. Tray filling sections consumes extra than the anticipated time, which generates queue. Owing to these discrepancies, economies are dented and decrease in customers' satisfaction.

The research aim is to improve and enhance the tray filling and packaging processes by applying time and motion methods. It will cut the flow time, labor requirement, and cost of production.

II. LITERATURE REVIEW

Manufacturing companies are finding it difficult to survive with challenges increasing from its competitor's day by day. To overcome these challenges, they have to improve their productivity, reduce the cycle time and operational cost. The organizations need to manage the production schedule, the work force and labor costs in an effective manner. In order to achieve all these goals time study is an important tool which needs to be worked on. The method is applied to the manufacturing processes which have been divided into parts with an objective to establish time standards for carrying out specific operations and setting up a production schedule in the factory Gauniyal et al (2014). The method of time study was developed by Frederick W Taylor who is considered as the father of Scientific Management. F W Taylor was an industrial engineer and focused on improvement of industrial efficiency. Time study involves various techniques of which Stopwatch technique and Predetermined time standard system (PTSS) are the widely used and the simplest. Although there are various other techniques like flow diagrams, multi- activity charts, operations chart, process flow chart and many more to list. But a using a stopwatch is the simplest way and record the timing on a time study sheet.

Research on work study incorporates a range of concerns, including its definition and management (Edo et al., 2001; Worrall and Smith, 1985; Watson, 1988; Aft, 2000). Although research on work measurement has evolved in a scientific and rigorous fashion, based on early works of Gilbert and others, the quantitative mathematical modelling of production activities in terms of time study has not evolved in a similarly rigorous fashion (Barnes, 1980; Zandin, 2003; Doty, 1989; Karger and Bayha, 2003). In recent years, the manufacturing organization used as the case example in this work has realized that scientific approaches could be developed to aid dispute settlement between the employees' association of the company and management regarding issues of productivity. In order to achieve this, the company was motivated to approach a management consultant. The reduction of cycle time has emerged as a fundamental element of new product development. Time study method is usually applied to measure standard time for the process. The time study techniques is applied under certain situation and the stopwatch time study is the best technique for manual production because human performance is not consistent from time to time. Patel, N. (2015).

According to Ralpha M. Barnes (2001) Frank and Lillian M. Gilbreth are known as the parents of motion study. Gilbreth begin investigation to find the "best way" of performing a given task trough analyzing the motions used by his workmen and he easily saw how to make improvements. He also possessed for analyzing work motion situations to enhance their ability for shorter or less fatiguing motions to improve the work environment. The research included the elimination of all useless motions and the reduction of those remaining motions. The elimination of this unwanted waste known as work simplification. According to Fred (1992), Elton Mayo started their research known as the human relations movement and he discovered that people work better when their attitude is better. He undertook a research project to study what factors affected productivity in the Hawthorne plant.

According to Fred E. Mayers (1992), time study was developed by Frederick W. Taylor in about 1880 which he is the first person to use a stopwatch to study and measure work content with his purpose to define "a fair day's work." He called as Father of Time Study. Among his study is 'Taylor Shoveling Experiment' which he studied between 400 and 600 men that using his own shovel from home to moving material from mountains of coal, coke and iron ore in around two-mile-long yards. Taylor identify that there have different size of shovels and he wondered which shovel was the most efficient. Thus, he used a stopwatch and measured everything that workers did. He recorded the data for every work in various ways with varied of shovels size, durations to done their work, number of breaks and work hours. The results were fantastic which reduced time, saving numbers of workers and yearly finances.

III. PROCESS FLOW CHART AND METHODOLOGY

International Match Factory match sticks and boxes are made in two different parallel processes. The flow chart of both the products has been shown in figure 1. In sticks processing the wooden logs are first cut down into the required pieces and then debarked the cut pieces. After the debarking operation the sticks are peeled out. The peeled sticks are then chopped, carburize and polished respectively. After polishing the sticks are then passed through vibrator for standard packing purpose. While the boxes are just printed initially on the printer and then screened for quality check and finally passed the breaking section. The room in improvement of any current method should not be a limited one. An analyst should cover and explore all the available and possible alternatives to improve the system by implying and replacing any current practice with a different method.

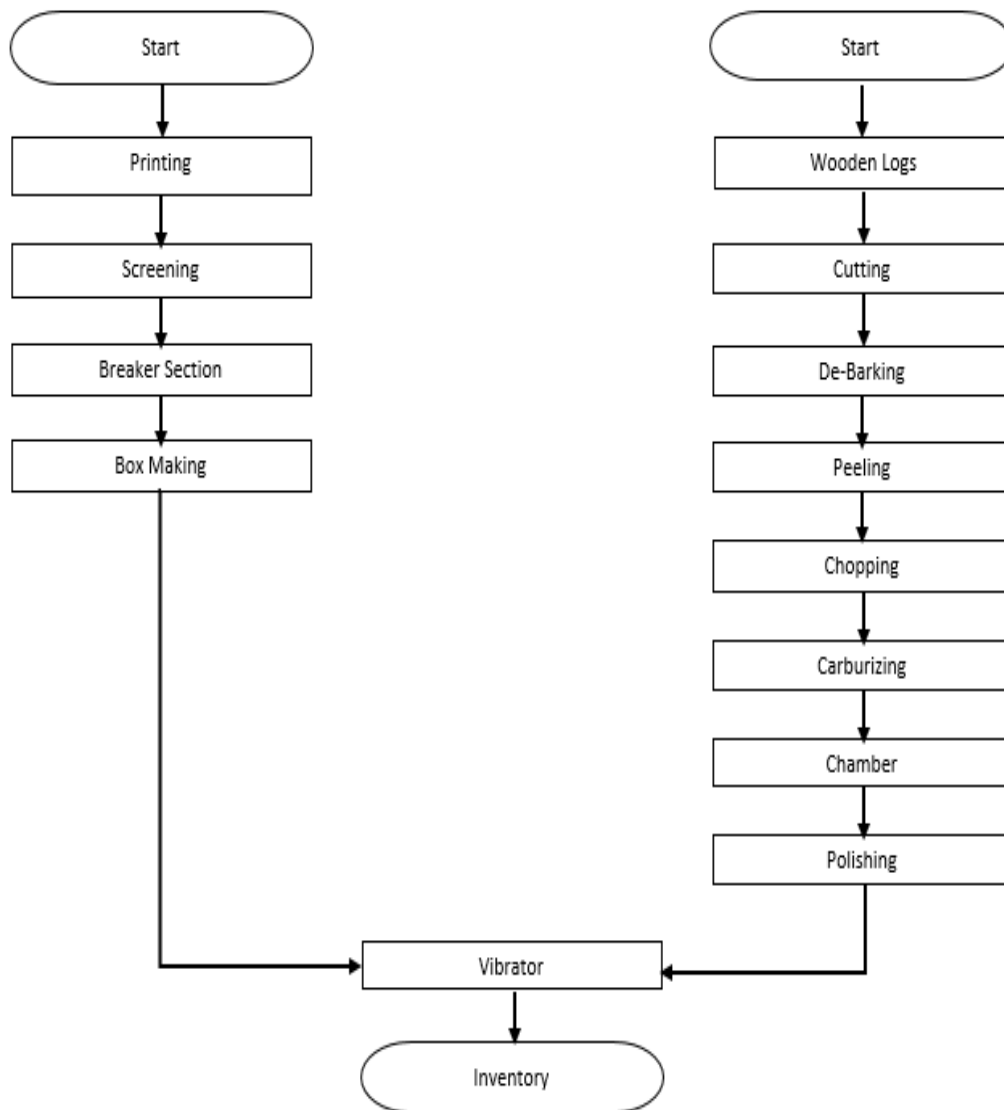


Fig. 1. Match stick process flow chart.

Following steps/approaches were conceived in developing a possible solution, from which the suitable work method would be segregated (Barnes, 1980, Heizer and Render, 2004): Firstly, Eliminate all the unnecessary work, secondly combine operations or elements (if any), thirdly alter the sequences of operations (if possible), and fourthly simplify the operations necessary.

The following steps were applied for improving the bottleneck at packaging and tray filling points:

1. Normal time for each packaging and tray filling points were calculated through stop watch which is used further to calculate standard time.
2. Tray filling and packaging sections were investigated and checked.
3. For prediction of true time, the desired number of observations within $\pm 10\%$ precision and 95% confidence-interval (CI) were attained with the help formula (Barnes, 1980), as: $N' = \left(\frac{20\sqrt{N\sum x^2 - (\sum x)^2}}{\sum x} \right)^2$, where x = individual observation /stop-watch reading; \sum = sum of the individual readings; N' = Calculated required number of observations.
4. For both, tray filling and packaging sections, the standard time was calculated with the help of following formula (Barnes, 1980): $Normal\ time \times \frac{100}{100 - allowance\ in\ percent}$
5. Afterwards, analysis charts were developed to understand the bottleneck point issues.
6. For both the concern sections, normal time was evaluated by subdividing the work into many elements with the help of a stop watch.
7. Both the steps (2 and 3) were repeated for each of the element.

8. Further investigation and analysis were constructed for the heavy time-consuming elements.
9. Possible solutions and alternatives were searched and evaluated by using principles of motion economy and appropriate tools from motion and time study and ergonomics (Barnes, 1980, McBride and Bobjer, 1999, Meyers and Stewart, 2002).

The term therblig is more convenient to use than hand motion or motion element and perhaps carries a more precise meaning. Although the word therblig is familiar to mechanical and industrial engineer, the term motion or hand motion is preferred when discussing the subject of micro motion study with factory and office personnel. The fundamental hand motions together with their letter symbol, mnemonic symbols, and color designation is shown in figure 2.

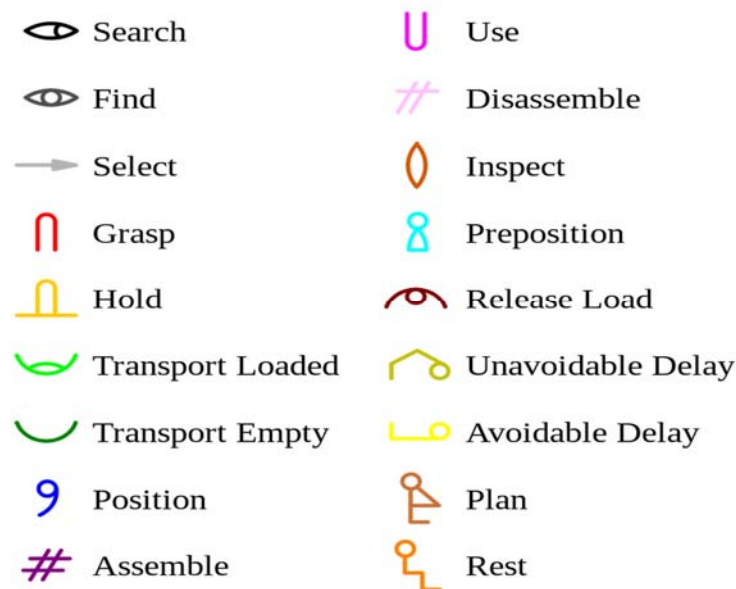


Fig. 2. Hand motions letter symbol, mnemonic symbols, and color designation

The set-in figure 2 consists of 18 elements, each describing a standardized activity.

- A symbol in black color shows attempting to find an object using the eyes and hands.
- A symbol in gray color indicate find operation i.e. a momentary mental reaction at the end of the search cycle.
- A symbol in light gray means choosing among several objects in a group.
- A symbol in lake red shows the grasping of an object with the active hand.
- A symbol in gold ochre color shows the holding of an object.
- A symbol in green color indicate the transport loaded which means moving an object using a hand motion.
- A symbol in olive green color indicate the transport empty action which means receiving an object with an empty hand.
- A symbol in blue indicate the positioning and/or orienting an object in the defined location.
- A symbol in violet heavy means joining two parts together.
- A symbol in purple color indicate the manipulating a tool in the intended way during the course working.
- A symbol in violet light means separating multiple components that were joined.
- A symbol in burnt orange means determining the quality or the characteristics of an object using the eyes and/or other senses.
- A symbol in sky blue means preposition means positioning and/or orienting an object for the next operation and relative to an approximation location.
- A symbol in carmine red color shows the release load i.e. releasing control of an object.
- A symbol in yellow ochre means waiting due to factors beyond the worker's control and included in the work cycle.

- A symbol in lemon Yellow means waiting within the worker's control which causes idleness that is not included in the regular work cycle.
- A symbol in brown means Plan deciding on a course of action.
- A symbol in orange color means resting to overcome a fatigue, consisting of a pause in the motions of the hands and/or body during the work cycles or between them.

IV. DATA COLLECTION AND ANALYSIS

The collection of data can be done in several ways, depending on study goal and environmental conditions. Time and motion data can be captured with a common stopwatch, a handheld computer or a video recorder (frames generation). There are a number of dedicated software packages used to turn a handheld PC into a time study device. As an alternative, time and motion data can be collected automatically from the memory of computer-control machines i.e. automated time studies.

A. Frames Generation

Development of frames from the captured video is an integral part of this study, which contributes into the elemental breakdown of work and time study. Frames are generated on a software by uploading video and setting the ranges to articulate the depth of a study. Figure 3 represents a collection of various generated frames used as a sample in the current study.

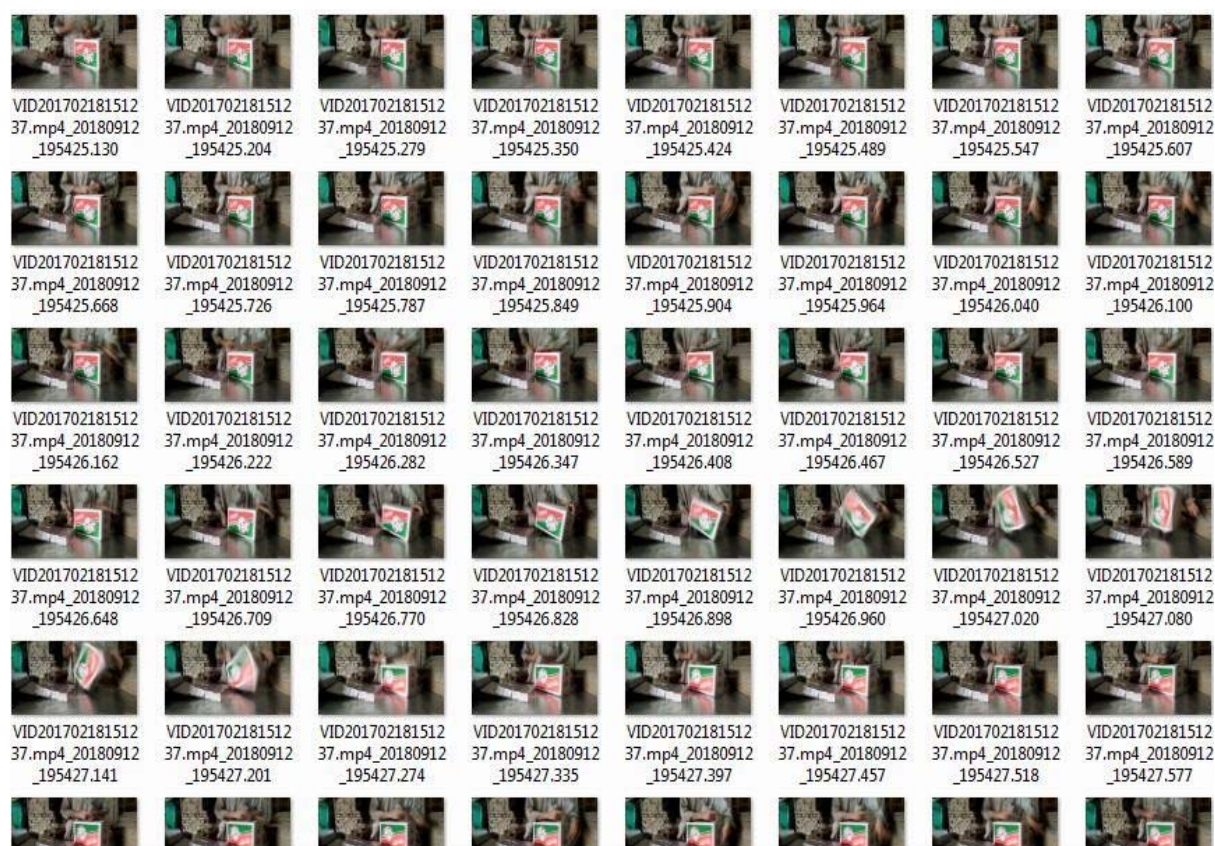


Fig. 3. Collection of various generated frames

Followed by the frame generation, analysis is carried out. For analysis, it is important to understand the fundamental hand motions. All the frames are played in a sequence and associated therbligs are searched and linked, these frames are sorted and segregated. Afterwards, calculation is carried out, e.g. in the packaging section, the video time (VT) = 13 seconds (sec), frames generated (FG) = 226, so frame time (FT) = FG/VT which comes out to be 0.0575 sec.

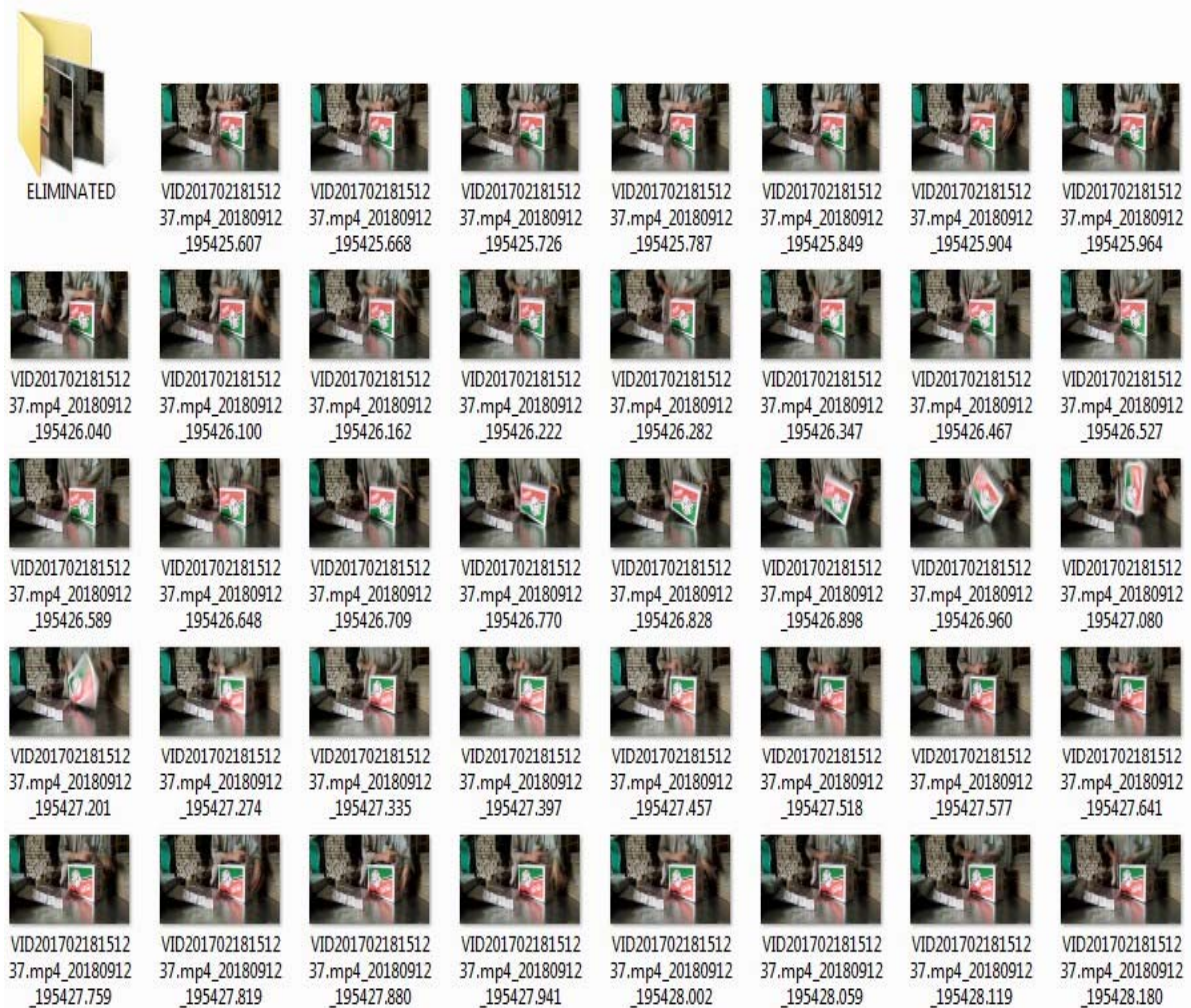


Fig. 4. Collection of various generated frames

As mentioned in the methodology, further investigation is carried out to eliminate the excessive unwanted motions, posture, twisting and bending, and over-reaching; in short, all those moments which are not valuable. For example, we made frames for therbligs USE which is 52 in number. After the elimination of 13 frames it remains 39 which is used for proposed improvement and calculation as discussed in the following section.

B. Observations and Analysis

An analysis chart has been developed for the wrapping section department in which the activities carried out for cartoon packaging are studied on the base of time. Samples are been collected as mentioned in the methodology section. Both normal time and standard times were calculated as shown in the table 1. Personal allowance for the operator was kept as 5% while the fatigue is 4% which makes a total allowance of 9%.

Table 1. Short cycle study sheet

Short Cycle Study Sheet		
Department: Wrapping Section Operation: Carton Packing	Operator Name: Ihsan Ullah Experience: 12 Years Station No. 08	Personal: 5% Delay: 0% Fatigue: 4% Others: 0% Allowance: 9%
Operated: Auto Foot Hand ✓ Physical Fitness ✓ Eye Sight ✓	Reason for Study: Original Study ✓ Method study change ✓ To check est standards ✓	
S. No	X	X²
1	12.85	165.12
2	12.70	161.29
3	12.65	160.02
4	12.04	144.96
5	12.51	156.50
6	12.13	147.13
7	12.47	155.50
8	12.28	150.79
9	12.79	163.58
10	12.63	159.51
11	12.97	168.22
Total	138.02	1732.62

Normal Time:

$$\sum X = 138.02$$

$$\text{Average Observed Time} = 138.02/11 = 12.54\text{sec}$$

$$\text{Rating factor} = 100\%$$

$$\text{Normal Time} = 12.54 * 100\% = 12.54 * 1 = 12.54 \text{ sec}$$

Standard Time:

$$\text{Standard time} = NT + (NT * \text{Allowances in Percent})$$

$$= 12.54 + (12.54 * 0.09) = 12.54 + 1.12 = 13.66 \text{ sec}$$

The developed analysis sheet for previously practiced method are presented on two-hand chart as shown in the table 2. In which there are twelve different studied activities, each activity is assigned with corresponding therblig and specified operating times.

Table 2. Two hand developed analysis sheet

MICRO MOTION STUDY Analysis Sheet, Old Method							
Operation: Packing Operator: Ihsan Ullah				Video no. 01 Sheet no. 01			
Activity	Therblig Symbol	Description Left Hand	Time	Activity	Therblig Symbol	Description Right Hand	Time
1	TL	Pick the carton	0.49	1	TL	Pick the carton	-----
2	P	Position the carton for boxes	1.63	2	P	Position the carton for boxes	1.63
3	TE	Movement of hands toward the boxes	0.69	3	TE	Movement of hands toward the boxes	0.69
4	TL	Putting the boxes in the carton	0.94	4	TL	Putting the boxes in the carton	0.94
5	TE	Movement of hands and twisting from tray to boxes	0.73	5	TE	Movement of hands and twisting from tray to boxes	0.73
6	P	Position the boxes to put into the carton	0.69	6	P	Position the boxes to put into the carton	0.69
7	TL	Put the box dozen box in the tray by hand	0.94	7	TL	Put the box dozen box in the tray by hand	0.94
8	A	Put the boxes into the carton	0.37	8	A	Put the boxes into the carton	0.37
9	A	Assemble and close the carton	0.75	9	A	Assemble and close the carton	0.75
10	AD	Twisting for the using of tab	0.48	10	AD	Twisting for the using of tab	0.48
11	U	Using of tap on the carton	2.96	11	U	Using of tap on the carton	2.96
12	RL	Releasing of carton	1.32	12	RL	Releasing of carton	1.32

The set-in table 2 consists of different Therblig symbols, each describing a standardized activity.

- A symbol “TL” indicate the transport loaded which means moving an object using a hand motion.
- A symbol “TE” indicate the transport empty action which means receiving an object with an empty hand.
- A symbol “P” indicates the positioning and/or orienting an object in the defined location.
- A symbol “A” means joining two parts together.
- A symbol “U” indicates the manipulating a tool in the intended way during the course working.
- A symbol “RL” shows the release load i.e. releasing control of an object.
- A symbol “AD” means waiting due to factors beyond the worker's control and included in the work cycle.

After doing time and motion study, the excessive motion has been analyzed and the best method of doing the work by a worker or machine has been determined. The developed sheet for previously practiced and the new methods are presented in the table 3.

Table 3. Improved Chart after time and motion study

Packing Section (Left Hand)				
S. No	Activity	Old Method	New Method	Remarks
1	TL	0.49	0.24	Improved
2	P	1.63	1.13	Improved
3	TE	0.69	0.69	Nil
4	TL	0.94	0.84	Improved
5	TE	0.73	0.25	Improved
6	P	0.69	0.19	Improved
7	TL	0.94	0.94	Nil
8	A	0.37	0.21	Improved
9	A	0.75	0.56	Improved
10	AD	0.48	0.38	Improved
11	U	2.96	2.21	Improved
12	RL	1.32	0.32	Improved
Total		11.63	7.96	

For twelve different studied activities it has been observed that time for 10 activities has been improved while for 2 activities i.e. movement of hands toward the boxes and put the box dozen in the tray by hand has been unchanged. The time for releasing control of an object has been improved the most followed by position the carton for boxes and position the boxes to put into the carton.

The old and improved SIMO chart after practicing time and motion study has been shown in table 4 and table 5 respectively, where status of improvement is mentioned for each elemental work.

Table 4. SIMO chart for old method

Process Name: Packing Operator Name: Ihsanullah		Department: Wrapping Section Old Method				Film # 01 Sheet number: 01/08	
Description Left Hand	Therblig symbol	Time	Time in 2000 of a min.	Time	Therblig symbol	Description Right hand	
Pick the carton	TL	16					
Position the carton for boxes	P	54		54	P	Position the carton for boxes	
Movement of hands toward s boxes	TE	23		23	TE	Movement of hands toward s boxes	
Putting the boxes in the carton	TL	31		31	TL	Putting the boxes in the carton	
Movement back for boxes	TE	12		12	TE	Movement back for boxes	
Position the boxes to put into carton	P	23		23	P	Position the boxes to put into carton	
Movement of boxes towards carton by hands	TL	31		31	TL	Movement of boxes towards carton by hands	
Put the boxes into the carton	A	12		12	A	Put the boxes into the carton	
Assemble and close the carton	A	25		25	A	Assemble and close the carton	
Twisting for the using of tap	AD	16		16	AD	Twisting for the using of tap	
Using of tap on the carton	U	98		98	U	Using of tap on the carton	
Releasing of carton	RL	44		44	RL	Releasing of carton	

SIMO stands for simultaneous-Motion Cycle chart. It is one of micro motion study devised by Gilbreth and it presents graphically the separable steps of each pertinent limb of the operator under study. It is an extremely detailed left- and right-hand operation chart. It records simultaneously the different therbligs performed by different parts of the body of one more operator on a common time scale

Table 5. SIMO chart for improved method

Process Name: Packing Operator Name: Ihsanullah		Department: Wrapping Section Improved Method			Film # 01 Sheet number: 01/08	
Description Left Hand	Therblig symbol	Time	Time in 2000 of a min.	Time	Therblig symbol	Description Right hand
Pick the carton	TL	8		—	—	—
Position the carton for boxes	P	37		37	P	Position the carton for boxes
Movement of hands towards boxes	TE	23		23	TE	Movement of hands towards boxes
Putting the boxes in the carton	TL	28		28	TL	Putting the boxes in the carton
Movement back for boxes	TE	8		8	TE	Movement back for boxes
Position the boxes to put into carton	P	6		6	P	Position the boxes to put into carton
Movement of boxes towards carton by hands	TL	31		31	TL	Movement of boxes towards carton by hands
Put the boxes into the carton	A	7		7	A	Put the boxes into the carton
Assemble and close the carton	A	18		18	A	Assemble and close the carton
Twisting for the using of tap	AD	12		12	AD	Twisting for the using of tap
Using of tap on the carton	U	73		73	U	Using of tap on the carton
Releasing of carton	RL	10		10	RL	Releasing of carton

In table 5 the status of improvement is mentioned for each elemental work. In detailed micro-motion study, there are twelve different studied activities, each activity is assigned with corresponding therblig and specified operating times.

Normal Time for Improved Method:

$$\text{Average Observed Time} = 7.96 \text{ sec}$$

$$\text{NT} = 7.96 * 100 = 7.96 * 1 = 7.96 \text{ sec}$$

Standard Time:

$$\text{ST} = \text{NT} + (\text{NT} * \text{Allowances in Percent}) = 7.96 + 7.96 * 0.09 = 7.96 + 0.71$$

$$= 8.67 \text{ Sec}$$

$$\text{OVERALL IMPROVEMENT} = (\text{Existence method} - \text{improved method}) / \text{Existence method}$$

$$= (13.66 - 8.67) / 13.66 = 0.36453$$

$$\text{Improved percentage} = 0.3653 * 100 = 36.53 \%$$

B. Tray Filling Observations

Similar to the study carried out at packaging section, an analysis chart has also been developed for the wrapping section department in which the activities carried out for cartoon packaging are studied on the base of time. At first attempt analysis chart and SIMO charts were developed for the currently practiced method with short cycle study as shown in table 6. Personal allowance for the operator was kept as 5% while the fatigue is 4% which makes a total allowance of 9%.

Normal Time:

$$\sum X = 382.26$$

$$\text{Average observed time} = 38.23$$

$$\text{Normal Time} = 38.23 * 100\% = 38.23$$

Standard time:

$$ST = NT + (NT * \text{ALLOWNCES IN PERCENT}) = 38.23 + (38.23 * 0.09) = 38.23 + 3.44$$

$$= 41.67 \text{ sec}$$

Table 6. Short cycle study sheet

Short Cycle Study Sheet		
Department: Wrapping Section Operation: Tray Filling	Operator Name: Saifullah Experience: 07 Years Station No. 03	Rating Factor: 100% Personal: 5% Delay: 0%
Operated: Auto Foot Hand ✓ Physical Fitness ✓ Eye Sight ✓	Reason for Study: Original Study ✓ Method study change ✓ To check est. standards ✓	Fatigue: 4% Others: 0% Allowance: 9%
S. No	X	X²
1	37.92	1437.92
2	38.92	1476.09
3	39.25	1540.56
4	38.54	1485.33
5	38.96	1517.88
6	37.87	1434.13
7	38.19	1458.47
8	37.92	1437.92
9	37.49	1405.50
10	37.45	1402.50
11	37.95	1440.20
Total	420.55 sec	16036.5

Data about the detailed micro-motion study is presented in table 7. After investigation and removal of unwanted or non-value-added motions, a comparative study is presented with respected outputs of left hand as shown in table 8, while right hand is in table 9.

Table 7. Two hand developed analysis sheet

MICRO MOTION STUDY Analysis Sheet, Old Method							
Operation: Tray Filling Operator: Shafi Ullah				Video no. 02 Sheet no. 02-08			
Activity	Therblig Symbol	Description Left Hand	Time	Activity	Therblig Symbol	Description Right Hand	Time
1	TL	Pick up the tray to load the boxes	1.49	1	TL	Pick up the tray to load the boxes	1.49
2	TE	Movement of the hand and twisting from tray to the boxes	0.71	2	TE	Movement of the hand and twisting from tray to the boxes	0.71
3	P	Position the boxes from tray while using left hand	3.96	3	P	Position the boxes from tray while using left hand	-----
4	TL	Put the box dozen box in the tray by hand	1.88	4	TL	Put the box dozen box in the tray by hand	0.78
5	TE	Movement of hands and twisting from tray to boxes	0.78	5	TE	Movement of hands and twisting from tray to boxes	5.85
6	P	Position the boxes from the tray	5.85	6	P	Position the boxes from the tray	1.56
7	TL	Put the box dozen box in the tray by hand	1.56	7	TL	Put the box dozen box in the tray by hand	1.36
8	TE	Movement of the hand and twisting from tray to the boxes	1.36	8	TE	Movement of the hand and twisting from tray to the boxes	6.82
9	P	Position the boxes from the tray	6.82	9	P	Position the boxes from the tray	1.38
10	TL	Put the box dozen box in the tray by hand	1.38	10	TL	Put the box dozen box in the tray by hand	1.43
11	TE	Movement of the hand and twisting from tray to the boxes	1.43	11	TE	Movement of the hand and twisting from tray to the boxes	7.34
12	P	Position the boxes from the tray	7.34	12	P	Position the boxes from the tray	2.86
13	TL	Put the box dozen box in the tray by hand	2.86	13	TL	Put the box dozen box in the tray by hand	4.74
14	AD	Wait for tray	4.74	14	AD	Wait for tray	0.26
15	TL	Movement for another tray	0.26	15	TL	Movement for another tray	

After doing time and motion study at tray filling section, the excessive motion has been analyzed and the best method of doing the work by a worker or machine has been determined. The developed sheet for previously practiced and the new methods are presented in table 8 for left hand, and in table 9 for right hand.

Table 8. Improved Chart (Left Hand) after time and motion study

Tray Filling (Left Hand)				
S. No	Activity	Old Method	New Method	Remarks
1	TL	1.49	0.84	Improved
2	TE	0.71	0.39	Improved
3	P	3.96	1.36	Improved
4	TL	1.88	1.3	Improved
5	TE	0.78	0.78	Nil
6	P	5.85	4.41	Improved
7	TL	1.56	0.98	Improved
8	TE	1.36	1.1	Improved
9	P	6.82	4.66	Improved
10	TL	1.38	0.78	Improved
11	TE	1.43	0.85	Improved
12	P	7.34	4.68	Improved
13	TL	2.86	2.21	Improved
14	AD	4.74		Eliminated
15	TL	0.26		Eliminated
Total		42.42	24.29	

From Table 8 it has been observed that out of fifteen different studied activities the time for 12 activities has been improved while for 1 activity i.e. movement of hands and twisting from tray to boxes has been unchanged. Also, time for 2 activities i.e. wait for tray and movement for another tray has been eliminated. The activity of positioning the boxes from tray while using left hand has been improved the most followed by position the boxes from the tray.

Table 9. Improved Chart (Right Hand) after time and motion study

Tray Filling (Right Hand)				
S. No	Activity	Old Method	New Method	Remarks
1	TL	1.49	0.84	Improved
2	TE	0.71	0.39	Improved
3	TL	1.88	1.3	Improved
4	TE	0.78	0.78	Improved
5	P	5.85	4.42	Improved
6	TL	1.56	0.98	Improved
7	TE	1.36	1.1	Improved
8	P	6.82	4.66	Improved
9	TL	1.38	0.78	Improved
10	TE	1.43	0.85	Improved
11	P	7.34	4.68	Improved
12	TL	2.86	2.21	Improved
13	AD	4.74		Eliminated
14	TL	0.26		Eliminated
Total		38.46	22.93	

From Table 9 it has been observed that out of fourteen different studied activities the time for 12 activities has been improved while for 2 activities i.e. wait for tray and movement for another tray has been eliminated. The activity of position the boxes from the tray has been improved the most followed by movement of hand and twisting from tray to the boxes. The improved SIMO chart after practicing time and motion study has been shown in table 10.

Table 10. SIMO chart for improved method

Process Name: Tray Filling Operator Name: Shafi Ullah		Department: Dozen Packing Improved Method			Film # 03 Sheet number: 05/08	
Description Left Hand	Therblig symbol	Time	Time in 2000 of a min.	Time	Therblig symbol	Description Right hand
Pick the tray to load the boxes	TL	28		28	TL	Pick the tray to load the boxes
Movement of hands and twisting from tray to boxes	TE	13		13	TE	Movement of hands and twisting from tray to boxes
Position the boxes for tray while using left hand	P	45		45	P	Position the boxes for tray while using left hand
Put the box dozen box in the tray By hands	TL	43		43	TL	Put the box dozen box in the tray By hands
Movement of hands and twisting from tray to boxes	TE	26		26	TE	Movement of hands and twisting from tray to boxes
Position the boxes for tray	P	147		147	P	Position the boxes for tray
Put the box dozen box in the tray By hands	TL	32		32	TL	Put the box dozen box in the tray By hands
Movement of hands and twisting from tray to boxes	TE	36		36	TE	Movement of hands and twisting from tray to boxes
Position the boxes for tray	P	153		153	P	Position the boxes for tray
Put the box dozen in the tray by hands	TL	26		26	TL	Put the box dozen in the tray by hands
Movement of hands from tray to boxes	TE	28		28	TE	Movement of hands from tray to boxes
Position the boxes for tray	P	156		156	P	Position the boxes for tray
Put the box dozen in the tray	TL	73		73	TL	Put the box dozen in the tray

In table 10 the status of improvement is mentioned for each elemental work. In detailed micro-motion study, there are thirteen different studied activities, each activity is assigned with corresponding therblig and specified operating times.

Normal Time for Improved Method:

$$NT = 24.29 * 100 = 24.29 * 1 = 24.29 \text{ sec}$$

Standard Time:

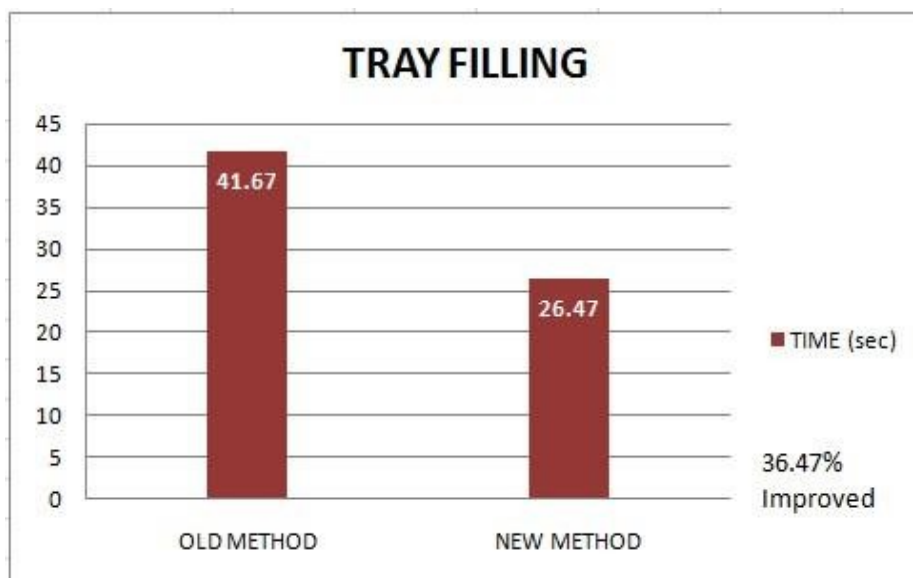
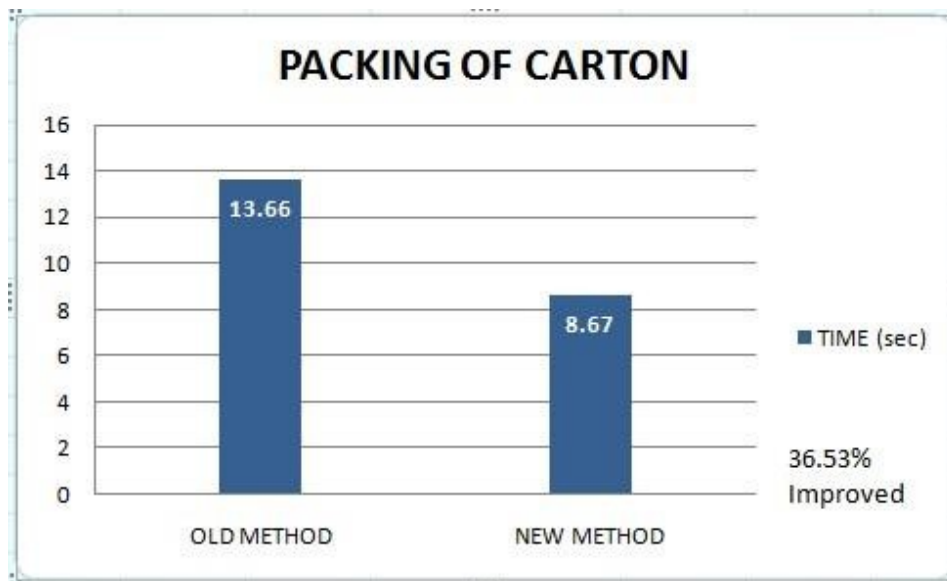
$$ST = NT + (NT * \text{ALLOWNCES IN PERCENT}) = 24.29 + 24.29 * 0.09 = 24.29 + 2.18 = 26.47 \text{ Sec}$$

Overall Improvement = (EXISTANCE METHOD –IMREOVED METHOD)/ EXISTANCE METHOD

$$= (41.67 - 26.47) / 41.67 = 0.3647 = 36.47 \% \text{ Improvement}$$

V. CONCLUSION AND RECOMMENDATIONS

By comparing the productivity of old method with improved method, it can be concluded that the overall improvement is 36.53% in the packing of carton section and 36.47% in tray filling section as shown in graphs below. It can also be concluded that overall performance can be improved by the following conditions i.e. Improve the methods or procedures adopted in performance of various jobs, develop suitable working conditions, the task must be oriented to achieve target i-e number of cartons packed per day, number of trays filled and disposed, to implement the recommended standard method, the worker must be trained properly.



For releasing load by twisting and reaching beyond the maximum working area it takes a lot time. Instead of doing so it would be better to install a gravity roller conveyor to eliminate all these unnecessary motions. It is found more convenient that the momentum of the body in the right direction could be easily controlled. Keep the materials which are frequently used, to the right of the body just in between the normal and maximum working area. There must be a chair for sitting during starvation for relaxing of the worker. The chair must be designed ergonomically. With the table there must be foot rest such that the worker can fit their feet alternatively, such that the fatigue caused by standing may be overcome. The footrest must be adjustable in height, angle and position.

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