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IMPLMENTATION OF LEAN TECHNOLOGY USING CELLULAR MANUFACTURING IN TEXTILE INDUSTRY

Nikhil Sharma[1], Dr. V.N. Bartaria[2]
M.Tech. ScholarProf.& Head of mechanical dept. Lakshmi Narain College of Technology, Bhopal
Lakshmi Narain College of Technology, Bhopal

Abstract: *In order to remain competitive, an industry needs to upgrade its technology, rationalize costs of production, improve product quality and speed of delivery, maintain high labour standards, and develop a domestic input base. Within this context, they implemented different methodologies which were practiced by different manufacturing sectors in different countries. Lean methodology is one of those concepts introduced to the textile sector with the objective of increasing productivity, improving product quality and cycle time, reducing inventory, reducing lead times and eliminating manufacturing waste. The main objectives of the present research work is to implement lean practices in a textile manufacturing factory, to assess its influence on manufacturing performance based on the performance of Lean implementation and to qualitatively compare the impact on the different sections of the company.*

Keywords: Lean Manufacturing, Lean Techniques, lean Sustainability

I. INTRODUCTION

1.1 Brief History: Starting in the 1980s with the first Toyota controlled production plant in the United States, the idea of Lean as derived from the Toyota Production System has become a popular method to improve production processes as well as any other procedure in organizations around the world. Implementation of lean helps many organisations to improve their efficiency and effectiveness; on the other hand numerous organisations have failed to benefit from lean philosophy. It is not important only to adopt the lean philosophy only, but more important is to implement the Lean and to make it sustainable all the way. Further implementation of lean must be seemed to be improved the performance of the company. The lean implementation is beyond the specific sector or type of the company. Most of the textile factories consists of central cutting department, three independent stitching lines and central finishing (packing) section. Textile manufacturing process consists of series of different steps. These steps are broadly divided into two categories pre-production and production process. The preproduction process consists of designing the textile, pattern design, sample making, production pattern making, grading and marker making. The production process consists of cutting, stitching (preparatory and assembly) and finishing.

1.2 Objective: The main objective of this paper to propose a best possible solution to reduce WIP by analysing the working environment in textile industry. This paper also suggest some improvement in the working culture of textile industry.

1.3 Method: The research consists of conducting time and motion study of stitching operations. By doing this, stitching operations will be standardized and production targets for each operation will be fixed. Secondly, batch processing is converted into single piece movement by the implication of new layout (cellular manufacturing). This will serve the purpose of WIP reduction. For the ease of operator movement between machines, sitting operations were converted into standing. The worker multi-skilling is achieved by the concept of assembly line balancing.

1.4 Expected Results: As in cellular manufacturing the numbers of operators are less than the number of operations (machines), one operator has to perform at least three to four operations. This will help to increase operator skill.Finally, flexibility in production is achieved by reduced WIP and multi-skilled operators, who can work on multiple styles immediately.

II. LITERATURE REVIEW

Manufacturing industry has shown a significant growth through increasing productivity and product quality while reducing product lead times utilizing variety of strategies which are based on technology, employees, process, product, material and management (Kumar 2006). A recent study on benefits of lean methodology by McGrath (2007) indicates that the main driver for becoming lean for most of the companies is to make profits either directly by reducing costs or indirectly by improving productivity. This may be the likely reason that many industries including apparel manufacturers opt to use the lean methodology in being competitive

At the early stages of its conception, the lean approach was used as a tool to improve the operational performance of an automotive manufacturer, but has now become a management approach for improving operational and socio-technical performance in all aspects of production (Joosten et al., 2009). Sanchez and Nagi (2001) define the lean concept as an operational practice which focuses on the productive use of resources.

In this research paper the textile industry nearby Bhopal (India) is taken under consideration, whose major products are wearing garments especially Men's formal shirt in various order size. The factory consists of central cutting department, three independent stitching lines and central finishing (packing) section.

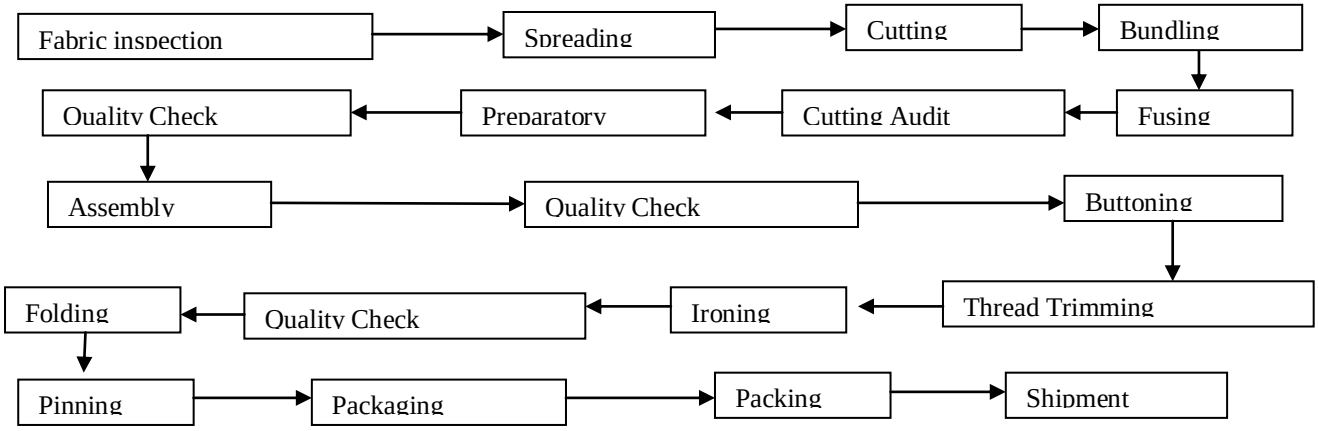

Figure2.1: Process of manufacturing the garments

Textile manufacturing process consists of series of different steps. These steps are broadly divided into two categories pre-production and production process. The preproduction process consists of designing the textile, pattern design, sample making, production pattern making, grading and marker making. The production process consists of cutting, stitching (preparatory and assembly) and finishing.

Figure 2.2: General Overview of the garments sewing

2.1 CUTTING SECTION

In cutting section fabric rolls are inspected as per work order. These inspected rolls are segregated on two sides as the quality pass and fail. Depending upon the order, size and quantity ratio; the spreader spreads the fabric for cutting. Once cutting is done, bundles of approx. 20 to 30 pieces are made and fusing is done simultaneously.

2.2 PREPARATORY SECTION

In preparatory section individual parts are made for assembly purpose. It consists of four sub sections Cuff, Collar, Front and Sleeve. Each of these sections includes the series of different operations to complete that part.

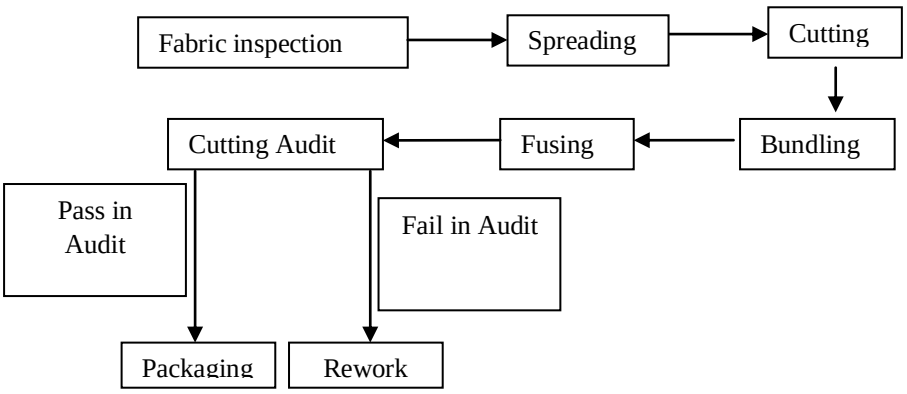

Figure 2.3: Preparatory Section

2.3 ASSEMBLY SECTION

This section consists of ten operations to make one full textile. The machines are kept in single straight line according to the operation sequence. The final textile from last operation is fully checked and corrected immediately for any defects.

The assembly section is made of including cuff section, Collar section, Front Section and Sleeve section. Further all these sections is being composed of various subsections. Like cuff section includes cuff Hem, Cuff trimming, cuff turning and blocking, cuff top stitch, cuff B hole and cuff press. Collar section includes collar run stitch, collar trimming, collar blocking, collar top stitch, collar band hem, collar band attach, collar band top stitch and collar notch making. Similarly front section includes the activity like pocket making, pocket hem, pocket press, pocket attach, left front placket, right front, front B. Hole, yoke label attached. And last section is sleeve section that include sleeve placket, sleeve diamond, sleeve b. hole, sleeve pleats. And after going through these entire section product goes to assembly section.

2.4 FINISHING SECTION

Finishing section consists of three major operations: buttoning and thread cleaning, ironing and final packing.

Buttoning	Button Attach
	Thread Trimming
	Thread sucking
Pressing	Sleeve Press
	Collar/cuff Press
	Body Press
Packing	Folding
	Single piece Packing
	Cotton Packing

Table 2.1: Operation in finishing section

2.5 EXISTING PRODUCTION LAYOUT

Existing layout of the sewing section (preparatory and assembly) is given in Figure below

Feeding from cutting	Cuff hem	Table for	Cuff Run Stitch
	Cuff run stitch		Cuff trimming

	Cuff top stitch	WIP	Cuff turning and blocking
	Cuff top stitch	MOVEMENT	Cuff buttom hole
Feeding from cutting	Collar run stitch		Collar rimming
	Collar top stitch		Collar blocking
	Collar band hem		Collar top stitch
	Collar band attach		Collar band attach
	Collar band top		Collar notch making
Feeding from cutting	Pocket marking		Pocket hem
	Pocket attach		Pocket Iron
	Pocket attach		Extra machine
	Left front placket		Right front
	Front button hole		Back yoke label attach
	Sleeve placket attach		
	Sleeve pleats		Sleeve diamond
			Sleeve button hole
Yoke feeding	Yoke attach		
Front feeding	Shoulder attach		
Sleeve feeding	Sleeve tacking		Yoke attach
	Sleeve attach		Shoulder attach
	Sleeve top stitch		Sleeve attach
	Side seam		Sleeve tracking
Collar feeding	Collar attach		Sleeve top stitch
	Collar close		Side seam
Cuff feeding	Cuff attach		Collar attach
	Bottom hem		Collar close
			Cuff attach
			Bottom hem

Table 2.2: Line diagram of Production layout

2.6 THE TEXTILE PRODUCTION PROCESS

There are three broad stages of textile production: cutting, sewing, and finishing. In this study, we focus on sewing for 3 reasons. First, sewing makes up roughly 80% of the factory's total labor employment; and is, therefore, the most appropriate setting to study the impacts of shocks to worker productivity. Second, output is measurable for each worker for each hour on the sewing floor and is extremely comparable across workers, lines, and textiles being produced.

Third, the number of lines, and hence supervisors, is sufficiently large and the mapping of workers to supervisors is sufficiently dynamic, yet clearly observable to allow for the study of the interaction between supervisors and workers experiencing shocks to productivity.

2.7 PRODUCTION DATA

The production data used in this study is collected using tablet computers assigned to each production line on the sewing floor. Each production writer, traditionally charged with recording by hand on paper each machine operator's completed operations each hour for the line, was trained to input production data directly in the tablet computer.

"III. METHODOLOGY"

The research is conducted in a selected textile industry located at nearby Bhopal, Madhya Pradesh. During the research process the time & motion study is prime concern, it helps to analyse the existing situation & thus predicting the alternative best solution.To calculate standard time for each operation, time study is conducted in the shop floor. To do this, the standard formal shirt is selected as a base line because operations differ from style to style and it is difficult to correlate all these operations of individual styles. After that, at least two operators were selected for each operation so that the difference in timing can be cross checked from the observed data of these two operators. To get better results, each operation time is taken for at least 15 cycles. Once time study is made by collecting raw data the performance rating is given to each operator and actual time is calculated for particular operation. Finally the Personal Fatigue and Delay (PFD) component is added on the calculated time and the operation time is standardized. The format of time study data collection sheet is being given below.

Time study Data Collection Sheet
Date:
Shift:
Name of Operator:
Name of Operation:
Machine RPM:
Machine Type:
Stitches Per Inch:

Name of Operation	Observed Time					Nos. of Cycle	Total Observed Time	Average Observed Time	Performance Rating	PFD Allowance (%)	Calculated Time
	1	2			10						

Note:
PFD:
Conducted By:

Table3.1: Time study Data Collection Sheet

While conducting time study some parameters are kept fixed (for example machine speed, stitches per inch, type of machine used etc.) to get consistent results. The PFD factor is taken as 15% of total time. This PFD is a little bit higher than normal industry standard; it is taken higher considering the standing operation and operator's movement inside the cell. Similarly the average performance rating is taken 100% for the ease of calculation only. This rating is adjusted average of actual ratings.The calculated SAM value for each section is being presented in the below table

Stitching Section	Stitching Operation	**Observed Time (Sec)**	**PFD Allowance**	**PerformanceRating**	**CalculatedTime (Sec)**
Cuff Section	Cuff Hem	24	15%	100%	27.6
	Cuff Run Stitch	35	15%	100%	40.3
	Cuff Trimming	23	15%	100%	26.5
	Cuff Blocking	20	15%	100%	23.0
	Cuff Top Stitch	33	15%	100%	38.0

	Cuff Button Hole	23	15%	100%	26.5
	Cuff Press	18	15%	100%	20.7
Total Cuff Section		176			202.4

Table 3.2: Cuff Section Operation SAM

Stitching Section	Stitching Operation	**Observed Time (Sec)**	**PFD Allowance**	**PerformanceRating**	**CalculatedTime (Sec)**
Collar Section	Collar Run Stitch	24	15%	100%	27.6
	Collar Trimming	16	15%	100%	18.4
	Collar Turning & Blocking	16	15%	100%	18.4
	Collar Top Stitch	31	15%	100%	35.65
	Collar Band Hem	15	15%	100%	17.25
	Collar Band Attach	34	15%	100%	39.1
	Collar Peak Ironing	15	15%	100%	17.25
	Collar Band Top Stitch	18	15%	100%	20.7
	Collar Notching	12	15%	100%	13.8
Total CollarSection		121			208.2

Table 3.3: Collar Section Operation SAM

Stitching Section	Stitching Operation	**Observed Time (Sec)**	**PFD Allowance**	**Performance Rating**	**Calculated Time (Sec)**
Front Section	Pocket Marking	13	15%	100%	15.0
	Pocket Hem	15	15%	100%	17.3
	Pocket Iron	35	15%	100%	40.3
	Pocket Attach	45	15%	100%	51.8
	Left Front Placket	25	15%	100%	28.8
	Right Front	32	15%	100%	36.8
	Front Button Hole	36	15%	100%	41.4
	Back Yoke Label Attach	33	15%	100%	38.0
Total Front Section		121			269.1

Table 3.4: Front Section Operation SAM

3.1 CREATING CELLULAR LAYOUT

In new cellular layout some operations were removed from the existing one. First, the quality checking points were removed from the preparatory, because the operator who is producing garments should be aware of quality standards and should work accordingly. After that, approximately four operations were removed from the process (three operations were combined with other operations and one operation is completely removed by changing the operation sequence). Once operations were finalized, creation of work cells takes place. In case of cuff section there are approximately six operations to make the complete cuff. Thus all these operations related to cuff sections are grouped in one cell. Similarly, operations of other sections are also grouped in their respective cells and given individual name. Total, five cells were created (four cells in preparatory section and one cell in assembly) to complete the garment.The assembly operations are kept at the centre and all other preparatory operations were aligned in four sides of assembly. The cells working in preparatory operations (Cuff, Collar, Front and Sleeve) were aligned such that the last operation of each preparatory section should directly supply its final products to the respective first operation of assembly (for example, cuff section supplies cuff to the cuff attach of assembly, collar section supplies collar to the collar attach, sleeve section supplies sleeves to the sleeve attach, front section supplies fronts to the shoulder attach of assembly section).

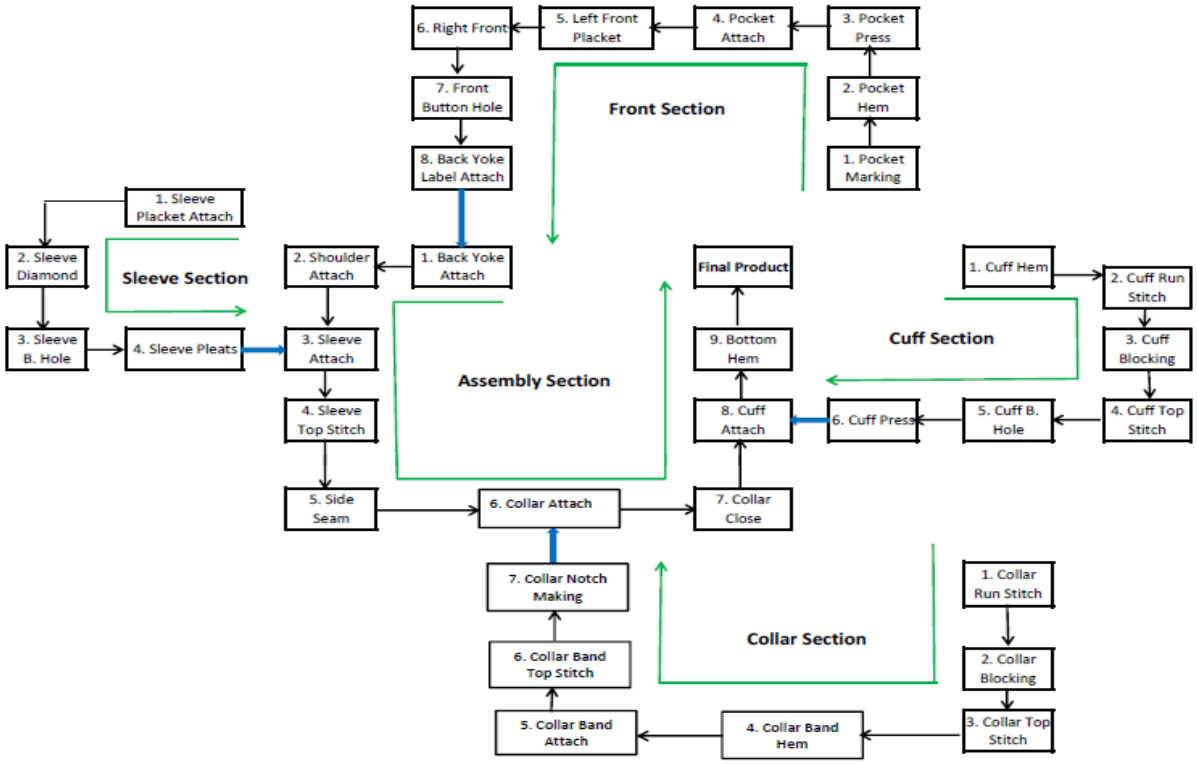

Figure3.1: Recommended stitching section layout

The cellular layout suggested in this research is selected for single piece flow because of cost effectiveness, operator skill enhancement as well as to shorten the time to implement it. Because there is no need for ordering or installing any new equipment, it is just re-arranging the available machines inside the shop floor.

3.2 WORK BALANCING BETWEEN OPERATORS

After defining work flow and creating cellular layout, the challenge is division of work between operators. The work should be divided in such a way that each operator should get equal work load. This will motivate operators in their work as a result of which there is improvement in productivity.

3.3 CRITICAL OPERATION HANDLING

Any product consists of a set of different operations with varying time and skill requirements in each stage. Even within the same work cell some operations are critical in comparison to others. In this research, the critical operations were identified for each cell. For example, in case of cuff section cuff run stitch (high time consuming) and cuff top stitch (special skill needed due to thickness of stitching area) are critical operations. In case of collar section collar band attach (due to large number of parts to be handled simultaneously) is critical operation. Similarly, the pocket ironing (due to frequent iron weight lifting) and pocket attach (due to different shapes of pocket as well as from the aesthetic point of view; because the pocket is in the centre of the garment in front side) are critical operations in front section and sleeve diamond making (garment folding skill for making diamond) for sleeve section.

3.4 TRIAL PRODUCTION ON NEW LAYOUT

The changes in the existing system, are crucial for any industry. It requires a firm support from management as well as workers. Everyone should be convinced for the better result of the test.

The operators were convinced by saying that if people move around the machine they will not tire of the same operation and can work more effectively as well as feel less tired. At the same time they will learn multiple operations within their cell, which increases their skill and confidence. Similarly, the balancing of a cell is as per standard allocated minutes; so all the operators were given equal work load within their cell. Earlier to this, the critical operators were blaming management and supervisors for allocating them in difficult operations. Now by the implementation of SAM for work balancing the problem of uneven work load is solved**.**

"IV. RESULT AND DISCUSSION"

Proves are shown below in the form of data & graphs, that the existing set up need to be upgraded as per our recommendations, it will improve the working culture as well as productionof the textile industry.Various comparison are listed down to show the result:

4.1COMPARISON OF PRODUCTION TIME

Production time of the garment has been reduced by 1.65 minutes (i.e. approximately 8%). This has been achieved by combining 3 operations with other operations (cuff, trimming combined with cuff run stitch, collar trimming combined with collar run stitch and sleeve tacking combined with sleeve attach) and by eliminating one operation (collar peak ironing removed by changing the shape of fusing, complete the work on different sections is shown in Figure below

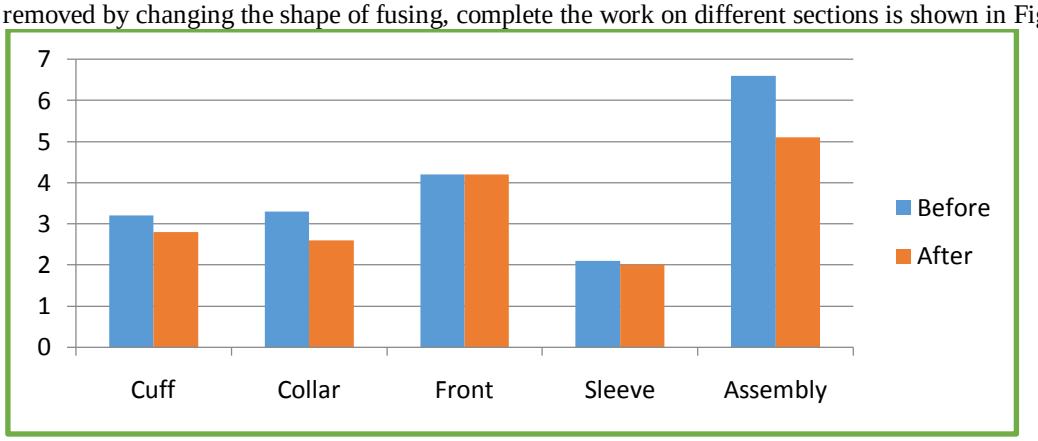

FIGURE4.1: Comparison of production time (Minutes) for different stitching sections

4.2 COMPARISON OF NUMBER OF OPERATION

The number of operation needed to complete a garment is reduced from 44 to 36. In total 4 operations were removed from stitching section and 4 operations from quality checking section. Those operations were not adding any value to the final product; so they were removed. The comparison of the number of operations before and after situations is shown in Figure 5.2.

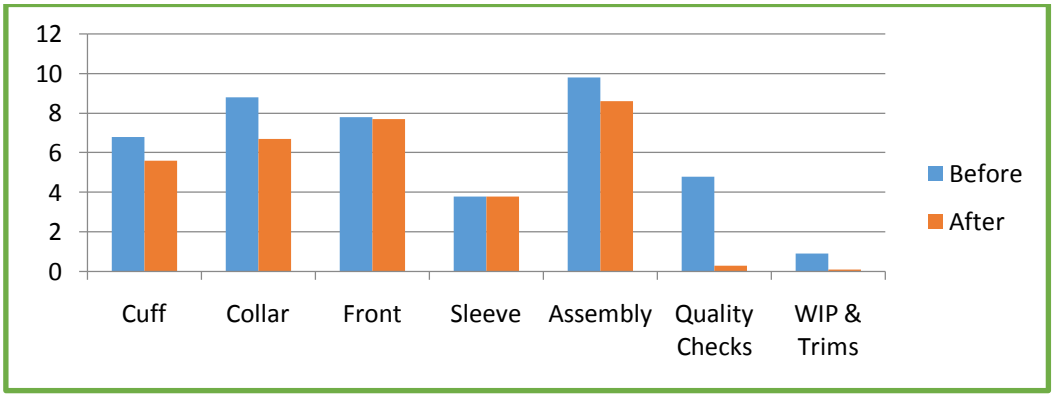

FIGURE 4.2: Comparison of number of operation indifferent sections

4.3 COMPARING NUMBER OF OPERATOR REQUIRED

In case of batch production, there used to be one operator in each machine and one additional person who can work at least in two to three operations for balancing the flow. The job of this extra operator is to support in critical operations and minimize operational bottlenecks. Whereas in case of single piece flow the operators are allocated as per standard allowed minutes in each cell and they will balance the work according to their need. In single piece flow, the rotation of operators is defined by the Standard Allowed Minutes (SAM) and situation of Work-In-Process (WIP). The number of operators used in different sections is being shown in figure

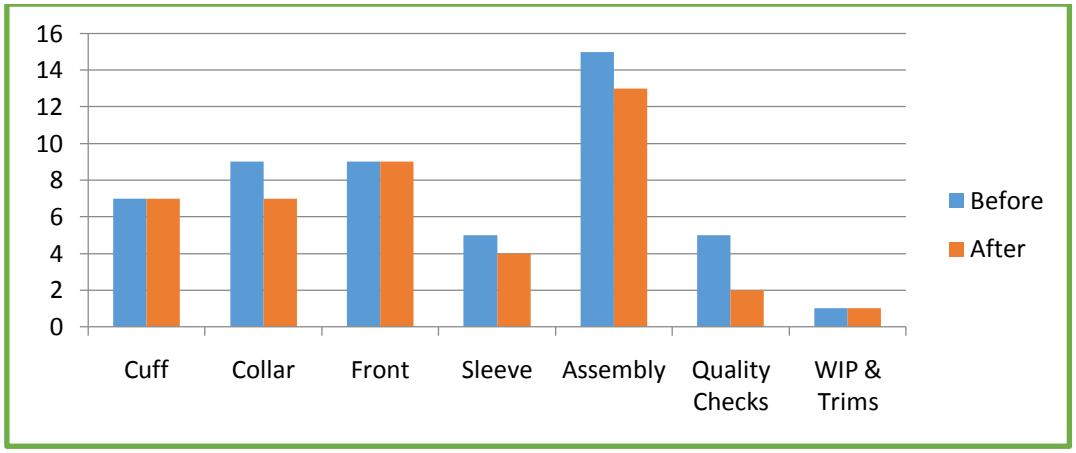

FIGURE 4.3: Comparison of number of operator required in different sections

4.4 COMPARISON OF INFORMATION FLOW & REWORK LEVEL

In existing layout the production line is very long, starting from preparatory to the end of assembly. Because of this, communication and information flow is difficult and for each and every thing supervisor has to walk around the line frequently. In case of new layout (cellular layout) the information flow is effective and quick. The rework level has been decreased by 80% over existing trends. In existing production, the rework level is approximately 5% but after implementation of recommended layout the rework level falls to 1%. The main reason for rework reduction is due to reduction in WIP and balanced work cells.

V. CONCLUSION

In this study the lean manufacturing tools and techniques were studied and used in case company (garment manufacturing industry). The problem of batch processing of existing company is addressed by using single piece movement of WIP. The problem of low flexibility is eliminated by cellular manufacturing, because there is very low WIP inside the process, so the line can be changed immediately if needed. This helps to make different kinds of products in the same production line depending upon requirements. By following JIT for production and purchase of items reduces in house WIP which serves two things. First, the unnecessary handling of large amount of raw materials and finished goods is reduced which saves store people's time as well as warehouse space. Secondly, the working capital requirement is also low because of small order size and fast rotation of fund due to short production lead time.

All stitching operations were standardized by means of time and working procedures, this will help management to know the production target per line and can make the production plan before loading actual products in the shop floor. This advance knowledge of the production target helps to allocate production operators on different styles according to the delivery schedule. In this way, small amount of money can generate significant profit.

VI. FUTURE SCOPE OF RESEARCH

In this research, only the stitching operations of a formal shirt are standardized due to time limitation and availability of running style during the time of research. But this work can be extended for any new style and data bank should be prepared for other styles also. This will minimize the duplication of work and it is easier to calculate standard time of new style by reallocation of some operations over existing. In the research the idea of cellular manufacturing has been implemented to increase the productivity. This can be further improved by using the system of group incentive and reward systems.

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