

# Sheet Metal Assembly Process Optimization Using Lean Manufacturing Tool

Kaanv Patel<sup>1</sup>, Aadit Khant<sup>1</sup>, Dipan Dholakia<sup>1</sup>

<sup>1</sup>Undergraduate student at PDEU, Gujarat, India

\*\*\*

**Abstract** - Numerous manufacturing firms in India experience a variety of issues, including long cycle times, a high number of rejections, unfulfilled orders, degraded quality, inadequate safety assurance, etc. Japanese lean production tools such as KAIZEN, 5S and Kanban aid in achieving continual improvement in the workplace. Applying these results in the removal or reduction of various wastes in a sector of the economy improves the organization's overall effectiveness. Assembly time reduction has appeared as an essential thing of improvement to produce a component of high quality in the least time possible with maximum resource utilisation. The following study was carried out at a CNC manufacturing company.

**Key Words:** Time Study, KAIZEN, Assembly process, Bolt Tray

## 1. INTRODUCTION

A sheet metal assembly of a single CNC machine took 6 hours to complete at the company. The simple task was to achieve the same quality of final assembly in the least possible time by optimizing the process. Various industrial engineering concepts were applied to achieve the aforementioned. The concepts are explained in brief below:

1. **Kaizen:** It is a Japanese term for "improvement" or "change for the better," and it refers to a way of thinking or doing things that are centered on always improving business, engineering, and manufacturing processes. Kaizen strives to reduce waste by enhancing standardized tasks and procedures.
2. **Cycle Time:** It is described as the actual amount of time needed to perform a series of tasks (one cycle).
3. **Time Study:** Time study is a structured technique of directly observing and measuring human work with a timing device to determine the time required for a qualified worker to complete the work at a set level of performance.

It adheres to the fundamental technique of systematic work measurement of:

- *Work analysis* into simple, clearly observable components or factors
  - *Measurement* of individual components
  - *Synthesis* of those measurements to arrive at a time for the entire job
4. **5S:** The term 5S is a housekeeping philosophy about maintaining order and cleanliness in the work area. The five Ss are:
- *Sort:* Sorting involves clearing the workspace of any extraneous objects and discarding them.
  - *Straighten:* The remaining tables, tools, parts, documents, and workbenches need to be sorted now that the mess has been removed. Keep everything at right angles while straightening as a general rule of thumb.
  - *Scrub/Shine:* The meaning of the third S is rather obvious. To help it look like a showroom, the work area should be thoroughly cleaned. The operators will feel proud of keeping the workplace tidy and orderly, and you'll discover that they'll want to continue doing so. Cleaning is beneficial for appearance as well as accident and injury prevention.
  - *Standardize:* Written criteria should be created to track the 5S program's development and compliance. As previously indicated, keep colors and identifications uniform and straight.
  - *Sustain:* Just developing the above given system is not enough. A company needs to maintain it, as humans we are naturally resistant to change, so an employee should be appointed who sees to the maintenance of the system.

5S improves employee morale, makes a fantastic first impression on consumers, and keeps the operation running smoothly with continual accountability and faith in the programme.

5. **Kanban:** It is a method for defining, administering, and enhancing knowledge-delivery services. It aids in visualizing tasks, increasing productivity, and always improving. Kanban boards represent work, allowing employees to maximize work delivery across various teams and handle even the most complicated projects in a single environment.

### 1.2 Existing Process

The sheet metal assembly of a typical 800mm bed size model consist of 52 pieces and 150+ nut bolts of various types. The complete process of putting together a whole body takes 2 workers about 6 hours (360 mins).

As for the bolt arrangement they were using a big trolley in which all the tools were kept. The issue with the trolley was that it could not be taken inside the sheet metal assembly.

The Old assembly process consisted of no standard operating procedure and the whole assembly was done by the workers according to their convenience and availability of equipment and material.

Timing for each activity was found using time study. To measure the time and record the duration of an activity, a continuous stopwatch was used. This eliminates the requirement for subtractions and enables the element times to be entered directly on the time study sheet. The time spent by each operator on the task, which they completed over a number of cycles, was recorded.

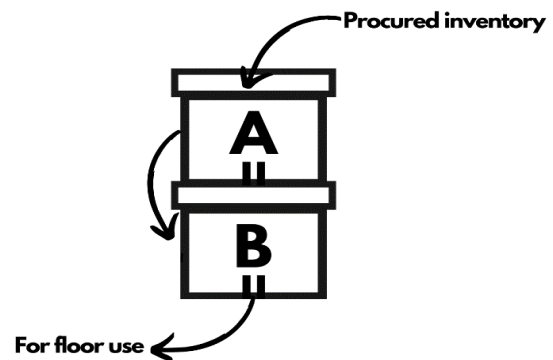
The time study data can be found below:

READING NO.	TOTAL TIME	WORKER - A	WORKER - B
1	351	351	328
2	346	346	331
3	333	333	315

### 1.3 Kanban application in the plant:

The company has been using two bin Kanban system to solve their inventory needs. The general working of the system is as follows: The 2-bin system, to put it simply, is a method of managing inventory that employs two actual bins, typically for small but essential parts (such as fasteners and components). It is a straightforward pull system in which containers contain the pieces.

The system is merely based on giving employees two plastic storage bins filled with inventory, which they can use to fill orders or supply supplies to various departments. The number of products put in the bins will depend on how quickly they are utilized individually

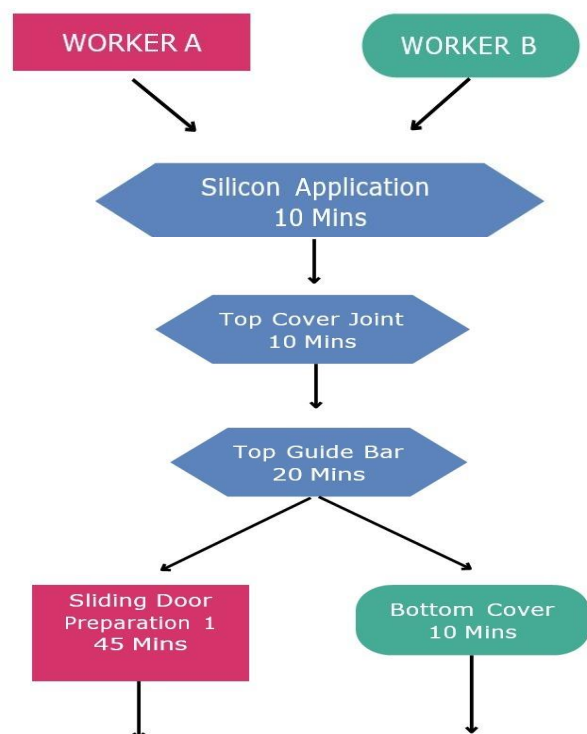


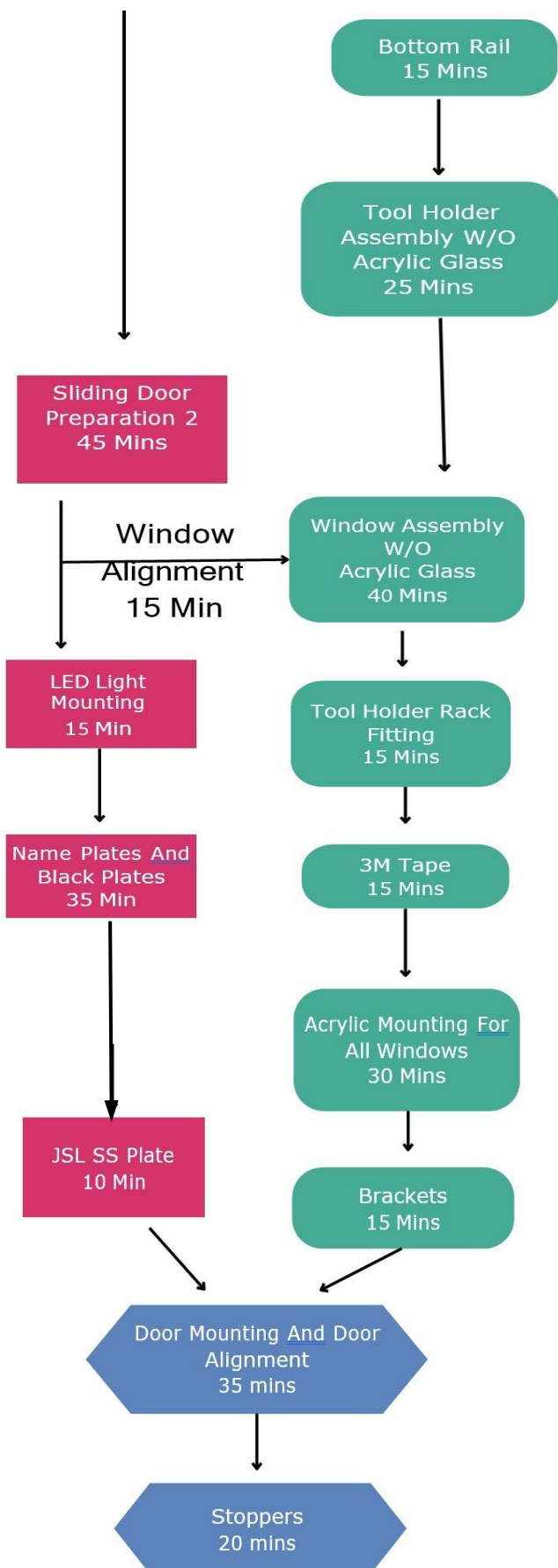
The employees take what they need from one bin until it is empty, at which point they switch to the second bin while simultaneously placing an order to restock the first bin with what they need. The first bin must be replenished with a predetermined quantity of goods, so there is little chance of running out of supplies (which could slow down production).

### 2. Improvements:

Introduction of a standard operating procedure for the workers with the inclusion of diversions for equipment and material shortages was experimented by us. The proposed process led to equal distribution of work over the workers. This led to better resource utilization. And a custom-made magnetic bolt tray was also introduced. All this made an improvement in the sheet metal assembly time.

#### 2.1 Proposed Flow Chart





Assembly Task	Estimated Time	Worker A	Worker B
Silicon Application	10		
Assembly of Right and Left Joint of Sheet Metal	20		
Top Cover Joint	10		
Top Guide Bar	20		
Sliding Door Preparation (1)	45		
Bottom Cover	10		
Bottom Rail	15		
Tool Holder Door Assembly W/O Acrylic Glass	25		
Sliding Door Preparation (2)	45		
Window Assembly W/O Acrylic Glass	40		
LED Light Mounting	15		
Tool Holder Rack Fitting	15		
3M Tape	15		
Name Plates and Black Plates	35		
Acrylic Mounting for All Windows	30		
JSL Plate	10		
Brackets	15		
Door Mounting and Door Alignment	35		
Stoppers Mounting	20		
<b>Total Time</b>		<b>280 min</b>	<b>280 min</b>

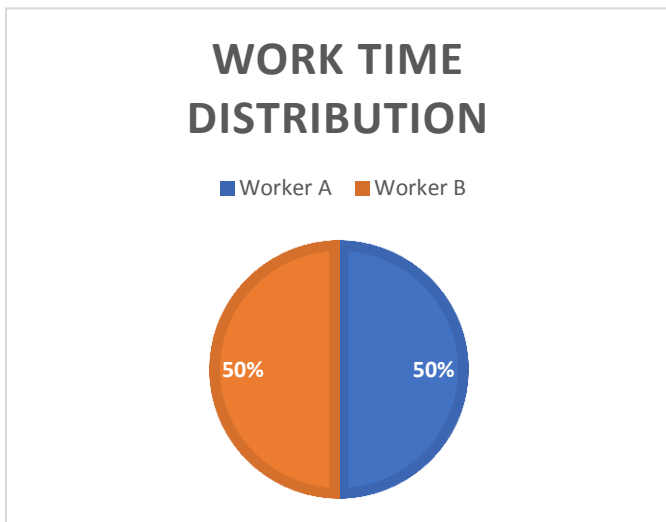
The flow chart can be interpreted as follows:

Task of the 2 workers have been divided in 3 blocks, Red is for worker A, Green is for worker B and Blue is where they both work together. The task has been written with the estimated time it takes a worker to complete it. The time for each task was recorded from the time studies conducted above and their average time was taken.

The excel table can be interpreted as follows:

Each row contains a task, it's approximate completion time and the green color indicates work allocation to the worker. The table was used during the application of the flow chart to cross check the results and write observations. The observations are further discussed in conclusion.

It can be deduced from the above table and flow chart that there is equal time-based work allocation between both the workers.



In case of equipment shortages, the workers were provided with a table beforehand, which contains the task which can be performed in such conditions.

Without Crane	Without Drill	Without 3M Tape
Name Plates	Window Hinges	Name plates
Door preparation	Unwrapping	Thread tapping
Application of 3M tape on tool door	Tray bolt Mounting	Window Mounting
Unwrapping	Black Plates	
Bolt mounting int the tray		

### 2.2 The Magnetic Bolt Tray:

We designed and built 2 magnetic bolt trays, one for the right and other for left side of the assembly. Each tray had exact number and size of slots as the required bolts. The

assembly uses very few nuts so no slots for nuts was provided. The tray was first made in Fusion 360 (CAD Software) the rendered images can be found below.



The tray used upcycled acrylic sheets from the window pane. Acrylic was drilled as per the design. A right-angle bracket from the headstock assembly of the CNC was used to hold the acrylic and the magnet together. We used an off the shelf magnet with the carrying capacity of approximately 2 kgs.



This tray created the following improvements: The workers now did not have to remember the number and sizes of bolts for the assembly, as when they arranged the tray with the bolts it is made sure that they have just the required bolts. The magnetic support of the tray made it very versatile as it can be attached on any section of the sheet metal assembly. Due to which there was a reduction in the worker's hand and feet movement.

### 3. CONCLUSION

It was observed that implementation of KAIZEN and the optimization of a standardized operating procedure in the assembly led to a 20% increase in productivity. There was a reduction in the lead time without making new resources available.

After the implementation of the above-mentioned process flow chart and the magnetic bolt holder tray we observed

the process and have come up with following issues which can be improved further:

1. Unexpected inconveniences caused due to different skill level of different workers and their experience.
2. Improvement in tray design to accommodate nuts and button bolts. Also, custom magnet to support the added weight will be needed.
3. A time study should be performed to segregate tasks in value and non-value adding tasks. This will further decrease the projected lead of the assembly.

## REFERENCES

- [1] Ortiz, C. A. (2006). *Kaizen Assembly: Designing, Constructing, and Managing a Lean Assembly Line* (1st ed.). CRC Press.
- [2] Tejas Rathod et al. A CASE STUDY ON APPLICATION OF KAIZEN IN INDUSTRY, International Research Journal of Engineering and Technology (IRJET), June 2019.
- [3] Jain, Ashish. (2015). The Kaizen Philosophy for Industries: A Review Paper.