



Investigation on Enhancing 6626 Shop Floor Using Lean and Ergonomic Principles

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Abstract: *Assembly lines are commercial, traditional and being striking resources of mass and large-scale manufacturing. With the development of organization form of the assembly line, an important verdict problem, known as the assembly line balancing problem, rises and has to be resolved. Based on the commercial, traditional technology of industrial manufacturing, a technique combined the simulation optimization is projected to resolve the problem. First one the process analysis and the work study are used to collect the basic data of line balancing. Second one analysis the bottlenecks on the assembly line and apply the relevant skills of industrial engineering to optimize these workstations. Third one finds out and decrease the waste in the assembly line. Eventually, the visualization simulation of manufacturing line system is deliberated in the paper, and also the application of simulation-optimization line balancing technique is projected in order to evaluate the project of enhancement. This research work focuses on improvement of 6626 shop floor by using lean concepts and ergonomic principles.*

Keywords: *Kanban system, Tray and Fascia Integration, Tray and Top box integration, Dispenser Unit, Cassette Configuration, Unit, Software Loading Unit*

1. INTRODUCTION

In today's world time is an important factor, especially all manufacturing industry are facing lot of problems due to time. Time is considered as the important of the industry. Time consumed by an industry includes both the non-value added and value-added activities. Basically, the non-value-added activities will consume more than the value-added activities. We can eliminate the non-value-added activities by implementing the lean manufacturing principles and ergonomic principles. In this concept the total cost and the profit percentage is fixed by industry which manufactures the product and the selling price is determined by the industry. In most industry price is fixed. Customers are more powerful than ever before. They have a wealth of optimal choice, Unparalleled admittance to data and demand admirable value at a reasonable value. In such a situation the only way to expand profit is to lower the cost. The great challenge of the twenty first century is not information technology it is the cost reduction. But we must reduce cost without,

- Decimating our team members.
- Cannibalizing our budges.
- Weakening our company in the long term.

1.1. Lean Manufacturing

In several organizations and companies nowadays becoming lean initiatives by swapping their old-fashioned bulk manufacturing systems with lean systems to advance quality, eradicate waste, and decrease delays and entire costs. A lean system accentuates the inhibition of waste: additional time, labour, or material consumed producing a product or service that doesn't enhance value to it. A lean system's unique techniques, methods and tools can benefit your organization decrease costs, accomplish just-in-time delivery, and curtail lead times. A lean enterprise fosters a company culture in which all employees continually improve their skill levels and production processes. Because, the lean systems are customer focused, determined and motivated, a lean enterprise's goods and services are shaped and distributed in the right quantities, to the right location, at the right. spell, and in the good

condition. Goods and services are manufactured only for a specific customer demand instead of being additional to an inventory stack. A lean system permits the manufacturing of an wide variety of goods or services, effective and quick changeover amongst them as required, effectual response to changing demand, and augmented quality. The goals of lean Enterprise is to advance quality, Eradicate waste, Decrease lead time, Reduce total costs.

2. METHODOLOGY

In this Research we are going to use two methods namely

- Heijunka
- Kanban system

2.1. Heijunka

Heijunka is a method of manufacturing-levelling that produces the right product mixture as demanded by the customer by making ideal consumption of the existing volume. The main purpose of heijunka is stabilizes production volume and variety by consolidating total number of customer orders

- Spreads out the production in an even manner through-out the day
- Ensures high order fulfillment rate
- Ensures internal production is balanced
- Established capacity is not over or under-utilized
- Numerous establishments need to manufacture what customers demands and when they demand
- They follow build-to-order method
- However, customer commands irregular manufacturing schedule turn out to be uneven
- This finally leads to huge amount of inventory, cancelled problems and inferior quality
- And rises the necessity for making balanced lean workflow called “Heijunka”.

2.1.1. Drawbacks of Unleveled Production

- Customers do not purchase goods certainly.
- There are several risks of unsold goods
- The usage of resources becomes instable and unbalanced
- Engaging an irregular demand on upstream methods

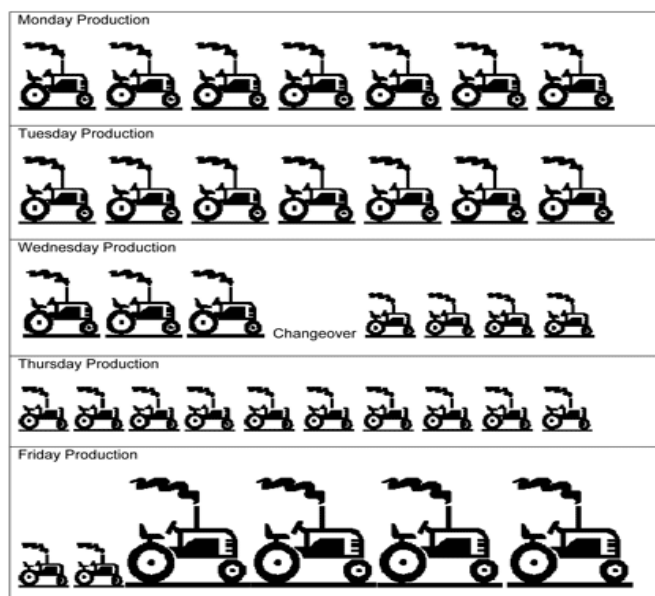


Figure2.1.1. Unleveled Production

2.1.2 Advantage of Heijumka over Unleveled Production

- To give flexibility in which customer wants when they want it
- To Reduce the risk of unsold goods
- Balanced usage of Labour and Machineries
- Levelled demand on upstream methods and the plant's suppliers.

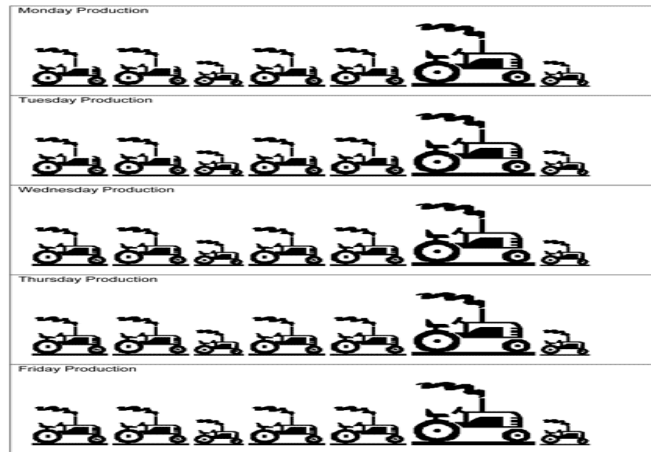


Figure2.1.2. Leveled Production

2.2. Kanban System

There are two common types of Kanban cards production Kanban and withdrawal Kanban. A production Kanban defines how many of what item a specific process needs to manufacture. Once workers have a production Kanban in hand, their process can begin manufacturing the item. A withdrawal Kanban is used to pull objects from a prior operation or a market, an area where materials are kept in a supermarket system.

1. An operator from the downstream method carries withdrawal Kanban to the upstream method's market. Each palette of supplies has a Kanban close to it.
2. When the operator of the downstream method extracts the demanded items from the market, the production Kanban is removed from the palettes of materials and is placed in the Kanban receiving bin.
3. For each production Kanban that is separated from a palette of materials, a withdrawal Kanban is devoted in its place. The two Kanban's are then related for steadiness to avoid manufacturing errors.
4. When work starts at the downstream method, the withdrawal Kanban on the palette of demanded materials is put into the withdrawal Kanban bin.
5. At the upstream method, the production Kanban is collected together from the Kanban getting bin. It is then located in the production Kanban bin in the similar order in which it was separated at the market.
6. Items are manufactured in the similar order that their production Kanban attain in the manufacturing bin.
7. The actual item and its Kanban is essential to move together when processed.
8. When a work procedure concludes an item, it and the production Kanban are placed collected together in the market so that an operator from the subsequent downstream process can remove them.

2.2.1. Benefits of Kanban System

- Reduce Inventory

Kanban will lower inventory, on normal, by 25 to 75%. This protects any company meaningfully in terms of rent, electricity, and storage space. In addition, all of the space freed by the application of a Kanban system can be used for upcoming expansions or new chances and prospects.

- Improve work flow

The visually planned environment confirms all parts are effortlessly found and repeatedly stocked. The rapidity of moving from one task to other is knowingly condensed by the creation of clearly marked flow lanes, Kanban cards, and evidently marked labels.

- Prevent Overproduction

Many parts are only created at the visual signal by the Kanban label (link), inventory is considerably less likely to be overproduced. Resulting in substantial savings in the holding of stock.

- Advances in responsiveness to fluctuations in demand

Contrasting a predictive system, Kanban instantly reacts to the environment. By retorting to obviously and easily read Kanban cards the lag time among the shift in demand and the shift in production is nearly non-existent. Minimize risk of obsolete inventory, since inventory is only created as it is required.

3. MEASUREMENT TECHNIQUE

3.1. Time Study

Time-study is well-defined as a work measurement procedure for recording the times and rates of working for the essentials of a specified job carried out under quantified circumstances, and for analyzing the data so as to attain the time required for carrying out the job at a well-defined level of performance.

3.2. Line Balancing

In production process, line balancing is valuable tool. Line balancing approach is to make production lines flexible enough to engage external and internal indiscretion. This approach includes setting a deliberate rate of manufacturing for essential materials to be fabricated within a specific time frame. Moreover, successful line balancing needs promising that every line segment's production quota can be met within the time frame using existing production capacity. This is an effective device to advance the throughput of assembly lines and work cell while reducing the man power necessities and expenditures. Assembly line balancing encompass the action of assemble diverse parts together, it comprises numerous production lines while normal line balancing may only comprise one production line. Assembly line balancing is the delinquent of passing on operation to the workstation end to end assembly line, in such a way the task be finest in some sense. The productivity difference among an optimal and sub-optimal task can produce parsimonies reaching enormous volume per year.

3.2.3. Objectives of Line Balancing

Following are the major purposes of line balancing technique. It is used to:

- i. Manage the workloads among assemblers.
- ii. Recognise the location of bottleneck.
- iii. Decide number of workstation.
- iv. Decrease production cost.
- v. Assigning task to each workstation in such a way that there is little idle time.

3.2.4. Terms in Line Balancing Technique

There is a range of terms used in assembly line balancing system. Each of them has their meanings and purposes.

- Cycle time
- Lead time
- Bottleneck
- Task precedence
- Productivity
- Takt times

The needed by competent worker or unattended machine to perform the task. This is usually expressed in minutes. Heizer and render quantified that takt time is pre-requisite techniques in undertaking line balancing task. There are numerous benefits of using takt time. These include,

- Achieve a steady and continuous flow of production.
- Eliminate waste of over production b producing actual customer demand.
- Improves accuracy of planning.
- Encourage the development of standardize work instructions, promoting quality and efficiency.
- Set real time targets for productions that shows operators exactly where their work output should be at any given point of time.
- Establish what-if scenario for customer demand based on flexible manning.



Figure3.2.1. *Main conveyor line*



Figure3.2.2. *Testing line*

4. ANALYSIS AND ITS SOLUTION

In this Research the model of 6626 machine is analyzed completely to identify the problem occurring during the assembly. Model 6626 is same as the model 6622 the only difference is the fascia is mounted on the rear side of the safe. In order to meet the customer demand the main line should have the capacity to produce a ATM machine at higher efficiency. We have observed the following

- Main aim of time study is to bring improvement in the main line.

$$\text{Takt Time} = \text{available time} = (8.4 * 60)$$

$$= 3.36$$

- customer demand 150
- Every stage in the main line has a standard time of 3:36mins.
- Complete cycle time data analysis is taken by physical examination of activities and video observation.
- In order to average out the time study data, we conducted number of iterations at different days and various time in a day.
- After taking time study the stages which are consuming more than 3:30 minutes are taken as bottleneck stages.

The 6626 shop floor has following assembly unit,

- Main assembly Line
- Shutter Assembly
- Front door Assembly
- Tray Assembly
- Fascia Assembly
- Tray and Fascia Integration
- Tray and Top box integration
- Top Box testing
- Retraction unit
- Main Line Testing
- Dispenser Unit
- Cassette Configuration unit
- Software Loading Unit
- Button up unit
- Packing

By Synchronizing the activities and defining a clear method of assembling the parts can make the value stream effective and create a pull in the flow of materials. This process flow diagram describes the flow of material in 6626 shop floor.

4.1. Problems Identified

As per the time study stages 11,14 are the bottle neck stages.

- Improper time allocation.
- Material shortage.
- Unskilled person.
- Motion of labors.
- Searching waste .
- Ergonomics of Work place is poor.
- Non Utilization of Midas.
- Due to the delay in the testing section the mainline is stopped.

4.2. Solutions

- In Proper allocation of time can be set for each stages (or) the bottle neck stages can be divided into several stages.
- In Proper kanban system can be implemented to avoid material shortage.
- Training can be given for unskilled labour.
- 5s can be implemented all over the industry.
- Actions of two or more tools can be combined to reduce the time .
- Motion of labour can be avoided by providing the tools and material as near as possible.

5. ANALYSIS

In this analysis phase the following activities are to be done to find the kaizens at each stage,

- Cycle time data is analyzed.
- Value added activities and Non-Value Added Activities are analyzed.
- Current state Layout is analyzed

5.1. Cycle Time Data is Analyzed

- Cycle time is the time between the completion of last work piece and starting the process for next work piece.
- Cycle time will differ for different operations and for different operators. Cycle time will decide the efficiency of the worker.
- By reducing the cycle time we can easily meet the takt time given by our customer.
- Cycle time can be reduced by reducing the non value added activities present during the process.
- Initially non value added activities consume more time than the value added activities. so when we eliminate the non value added activities automatically the take time will be reduced.
- The value added and the non value added activities can be separated by the video observation.
- The model 6626 has many stages and these stages has several functions .these functions are mentioned below.
- In two methods to improve downtime and reducing man power and analyze the different location of the part.
- In some stage to be consider as industry. Mainly focus on stage 4 and stage 11.To analyze the break time of different stages.
- Mainly consider as AC assembly unit,IO hardness rounting,core assembly.

Table5.3.1. *Main stages*

Stage-1	Fitting power supply unit
	switch box assembly
	Harness rounting
Stage-2	Earth stud
	Main AC filter assembly
	mouse plate assembly
	RIO plate assembly
Stage-3	slim line heater
	safe model harness rounting
Stage-4	IO harness rounting
Stage-5	AC power harness rounting
	interlock bracket switch (CM1)
	harness rounting
Stage-8	Interlock bracket switch (CM2)
	Rretraction assembly
Stage-9	Cable tie harness rounting
	retraction harness rounting
Stage-10	Fitting of UPS
Stage-11	core assembly
	core bracket
	VGA harness rounting
	audio cable
	yellow label
Stage-12a	SPS harness rounting
	door harness rounting
	Facia EPP USB power cables
	plastic short sleeve fit
Stage-12b	All DC harness connection
	VGA connection harness rounting
Stage-13	harness rounting
Stage-14	fitting of facia
	encrypted pin pad
Stage-15	audio harness
	display harness
	EPP heater rounting harness
	VGA rounting

Table 5.3.2. Bottle neck stages

		TRAIL 1		TRAIL 2		TRAIL 3	
		TOTAL TIME	BREAK UP	TOTAL TIME	BREAK UP	TOTAL TIME	BREAK UP
sstage-11		0:06:29		0:06:00		0:05:56	
	core assembly		0:00:40		0:00:40		0:00:40
	core bracket		0:00:33		0:00:35		0:00:33
	VGA harness rounting		0:01:15		0:00:55		0:00:55
	audio cable		0:01:15		0:01:01		0:01:05
	yellow label		0:01:02		0:01:17		0:01:02
	HUB USB connection		0:01:00		0:00:57		0:00:56
	COP vga harness rounting		0:00:28		0:00:22		0:00:28
Idle		0:00:16		0:00:13		0:00:16	
stage-13		0:04:26		0:03:25		0:03:55	
	harness rounting		0:03:59		0:03:09		0:03:34
	Idle		0:00:27		0:00:16		0:00:22
stage-14		0:04:50		0:06:02		0:05:15	
	fitting of facia		0:02:35		0:02:59		0:02:45
	encrypted pin pad		0:02:02		0:02:44		0:02:12
	Idle		0:00:13		0:00:19		0:00:18
stage-19		0:03:32		0:03:42		0:03:50	
	dispenser assembly		0:01:34		0:01:32		0:01:42
	connection harness rounting		0:01:50		0:02:04		0:01:52

6. RESULT AND DISCUSSION

To way of Improvements can be made possible by implementing the following methods

6.1. Kanban System

By implementing the Kanban system we get

- Required level of inventory
- Material shortage is eliminated so there will be no waiting waste.
- Work in progress inventory will be reduced.
- Flow of the material will become constant.
- The production Kanban and with drawal Kanban defines the exact requirements of the product.

6.2. Heijunka

By implementing heijunka in the production line we get the following benefits

- There will be product flexibility in the production line so that we can produce various models of ATM machines per day.
- It also reduces the inventory level.
- It will enable the production line to move in a balanced mode with flexibility.
- It describes the accurate time for each and every process.
- It reduces the overtime required.
- We can easily predict the work schedule.

6.3. Improvement In Stages

- We identified that the stage 11 and stage 14 in the model 6626 are acting as the bottleneck stages.
- The operation in stage 11 called HUB USB connection and harness rounting are consuming more time.
- As well the operation called fixing encrypted pin pad in stage 14 is consuming more.
- As a result these operations can be divided into two stages namely 11(a),11(b),14(a),14(b). So that we can balance the standard time.

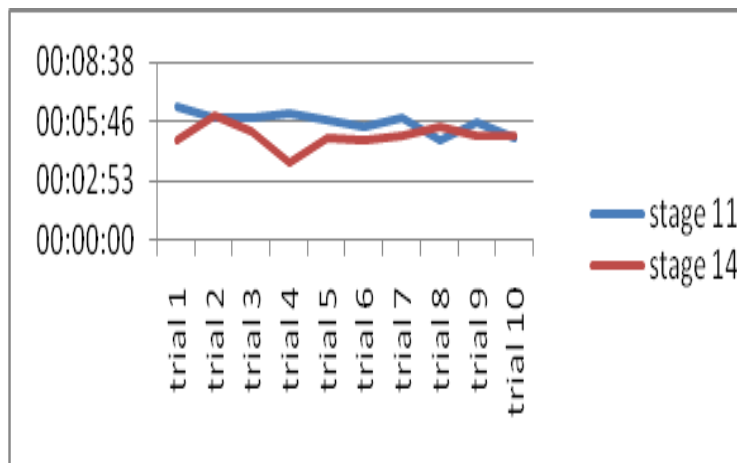
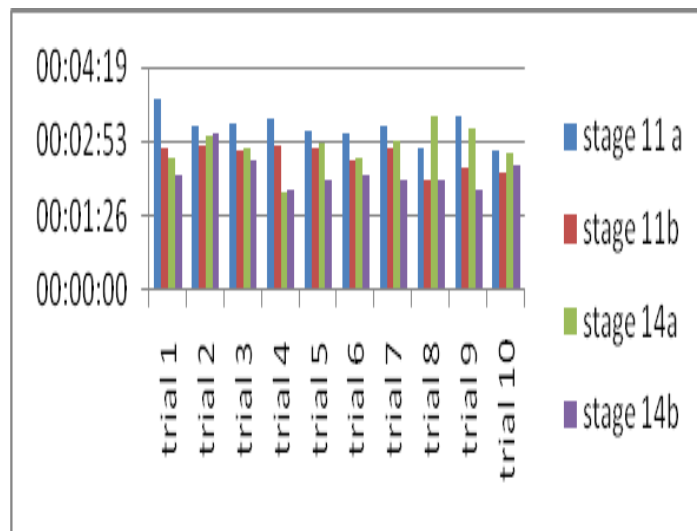


Figure 6.3.2. Line and column chart for bottle neck stages



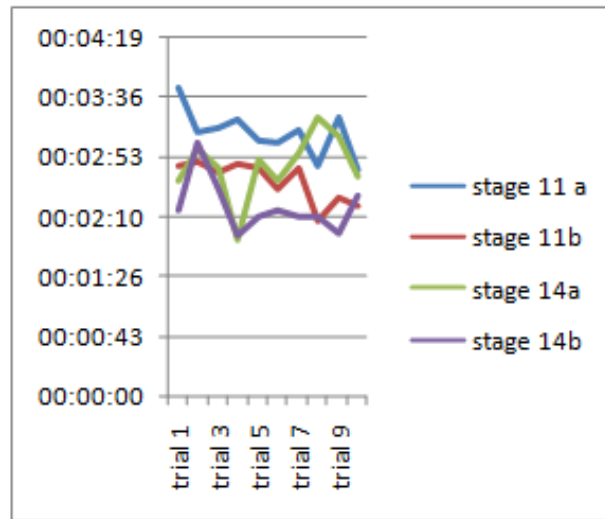


Figure 6.3.3 bottle neck stages after implementing break up time

Table 6.3.1 bottle neck stages after implementing solution

		TRAIL 1		TRAIL 2		TRAIL 3	
		TOTAL TIME	BREAK UP	TOTAL TIME	BREAK UP	TOTAL TIME	BREAK UP
stage-11a		0:03:43		0:03:11		0:03:13	
	core assembly		0:00:40		0:00:40		0:00:40
	core bracket		0:00:33		0:00:35		0:00:33
	VGA harness routing		0:01:15		0:00:55		0:00:55
	audio cable		0:01:15		0:01:01		0:01:05
stage 11 b		02:46		02:49		02:42	
	yellow label		0:01:02		0:01:17		0:01:02
	HUB USB connection		0:01:00		0:00:57		0:00:56
	COP vga harness routing		0:00:28		0:00:22		0:00:28
	Idle		0:00:16		0:00:13		0:00:16
stage-14a		0:02:35		0:02:59		0:02:45	
	fitting of facia		0:02:35		0:02:59		0:02:45
stage14 b		02:15		03:03		02:30	
	encrypted pin pad		0:02:02		0:02:44		0:02:12
	Idle		0:00:13		0:00:19		0:00:18

7. CONCLUSION

In this project the line balancing of 6626 shop floor is improved by improving the following through various lean tools Line balancing improved by,

- Improving the Flow of Material using kanban.
- Reducing waiting time by heijunka.
- Improving Work ergonomics by proper arrangement of bins and materials.
- Standardizing the Work for all assembly.
- Defining Standard Operating time for all assembly.
- Providing andon system in kernel assembly for eliminating pallate shortage.

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