

KANBAN APPLIED TO REDUCE WIP IN CHIPPER ASSEMBLY FOR LAWN MOWER INDUSTRIES

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ABSTRACT

Because of market competition and rapid technology development, managements of manufacturing industries are in pressure to improve productivity and cost effectiveness of their products. This leads manufacturing industries to adopt the philosophy of time-based management of inventory using Kanban technique- an integrated Just In Time (JIT) philosophy. This paper presents a case study of Kanban applied to a leading Australian lawn-care products manufacturing company. Real life data is used for illustration. It analyses the overall benefits to the company by implementing Kanban technique to one of its major assembly area.

KEYWORDS

Just in time (JIT), Kanban, Balancing, Inventory management.

1.0. INTRODUCTION

Excess work in progress (WIP), costs of labour, demand variations, unreliable deliveries of raw materials, defects, machine breakdown, processing time variations, and excessive set up times are the main problems with the traditional push systems in manufacturing. During the past years much attention has been devoted to the concept of Just In Time manufacturing as an alternative to the traditional push systems. Just In Time (JIT) is a management philosophy used to eliminate sources of production waste by producing the right amount in the right place at the right time which should improve profits and return on investment. It helps in increasing the inventory turnover rate, reducing variability, improving productivity, reducing lead time, and costs associated with machine setup and equipment breakdown (Kabrychy et al, 1985). Kanban is one of the primary techniques of JIT philosophy which signals a cycle of replenishment for production and materials. It is one that meets high throughput or service demands with very little inventory. Kanban is a card based control system to transfer instruction based on logic that nothing will be produced until needed. It maintains an orderly and efficient flow of materials throughout the entire manufacturing process.

In this paper we present a case study of application of Kanban technique in a leading Australian lawn-care products manufacturing company. This paper focuses on steps and activities carried out to implement Kanban system for an existing product. These steps and activities include developing workstation for the chipper assembly area, designing and placement of assembling facilities, and balancing the workflow of the assembly process to ensure the efficiency of the line.

The outline of this paper is: Section 1 introduces problems and scope of work. Section 2 provides overview of Kanban technique. Section 3 describes the steps and procedures used in implementing Kanban. Section 4 analyses the outcome of this implementation. The summary of this paper is presented in the final Section.

2.0. REVIEW OF KANBAN

Kanban is an integrated JIT philosophy. The Japanese term Kanban means "visual record", which was originally developed at Toyota in the 1950s as a way of managing material flow on the assembly line. It is a control system used to put in place Just In Time (JIT) concepts by using cards as signals to control production and transfer instructions.

The Kanban technique has attracted attentions from many researchers since it was first brought to light in early 1980s (Wang and Sarker, 2005). The methodologies for computing the required number of Kanban range from economic- order-quantity (EOQ) models to complex nonlinear programming models, queue theoretic models, and dynamic programming models. A literature review on just-in-time (JIT) manufacturing systems and Kanban operations can be found in Akturk and Erhun (1999) and Price et al. (1994). Akturk and Erhun classified the techniques of Kanban and provided both the design parameters and Kanban sequences for a JIT manufacturing system. Price et al. (1994) presented the review of optimization models that determine the number of kanban cards at each workstation and the size of kanban lots. Tardif and Maaseidvaag (2001) introduced an adaptive kanban-type pull control mechanism to determine release or reorder time for raw parts for the case of a single-stage, single-product kanban system, they assumed the demands occur according to a Poisson process and processing times are exponential random variables. Herer and Shaolom (2000) simulated the use of a non-integral number of kanban cards in the production system and explained how one can predict the performance of such a system. Gupta and Al-Turki (1997) introduced a methodology to manipulate the number of kanbans in a JIT system. Sarker and Balan (1996, 1998, 1999) and Nori and Sarker (1996, 1998) determined the number of kanbans between two workstations for both single-stage and multi-stage kanban systems. Parija and Sarker (1999) analysed a supply chain system by determining the raw material ordering policy and finished goods delivering policy.

2.1. Essential Rules for Kanban

There are six essential rules for implementing Kanban. These are:

Rule 1: Do not send defective products to the subsequent process:

The purpose of this is for eliminating defects that must not send to the subsequent process. In order to follow this rule carefully, machines must be made to stop automatically when they produce defectives, and workers must stop their operations. If defective products get mix up with good products, exchange them promptly. Unless there is an assurance that parts flowing through all the processes are good products, the Kanban system itself will fail.

Rule 2: The subsequent process comes to withdraw only "when is needed":

The subsequent process will not randomly withdraw for the preceding process. This means:

1. No withdrawal without a Kanban
2. Items withdrawn cannot exceed the number of Kanban submitted
3. A Kanban must always accompany each item

Rule 3: Produce only the exact quantity withdrawn by the subsequent process:

Entire production process should function like a single conveyor where parts are withdrawn and assembled simultaneously.

Rule 4: Equalise production:

Each process should be able to deal with the requirements of the following process without resorting to produce materials ahead of time when it has excess time or capacity.

Rule 5: Kanban means fine tuning:

Kanban only should respond to the need of fine tuning but not major change. Full potential is realized only when it is used effectively under fine tuning.

Rule 6: Stabilize and rationalize the process:

The load-smoothing of the system is required to support to become more efficient.

3.0. IMPLEMENTATION OF KANBAN AT ASSEMBLY PLANT OF LAWN CARE PRODUCTS

This is based on a leading Australian lawn care product manufacturing company. It produces various models of lawn care products and accessories. Previously, the company had manufacturing resources planning (M.R.P) system to control means of operation. Most of the jobs and order instructions were carried out manually before a product was finalised and work used to carry out by the manager and employees. Therefore a considerable amount of time was wasted in the handling of parts and in ordering them from the management people to the work centre. The company was making only a little profit because of these reasons. The management of the organisation decided to change from current MRP system to Just in time (J.I.T). A project was undertaken to implement Kanban technique to control production throughout the entire process. This case is based on one of the several processes where Kanban was applied. The implementation process follows three major steps such as development of workstations for Chipper assembly, designing facilities and tools, and balancing of the assembly area.

3.1. Development of Workstations for Chipper Assembly

This major step consists of the following two sub-steps:

a) Determination of number of required workstations:

The initial layout of the product was tentative and assembly was not organized properly. Parts were assembled manually in different locations. Therefore considerable amount of time were wasted for works in progress causing bottleneck in production process. The main objective is to get all the assembly process into one assembly area to obtain continuous flow process. Details of the assembly processes are documented and analysed. Based on the information obtained, the number of workstations required for the assembly consists of rotor assembly, enclosure assembly and drive assembly.

b) Analysis of layout:

Each workstation consists of several components. Work steps and components of the assembly for each workstation are determined first. For each station, the assemblies represented by layout addresses each task to perform. Figure 1 shows the precedence diagram for Chipper assembly. These diagrams also show relationship of each assembly.

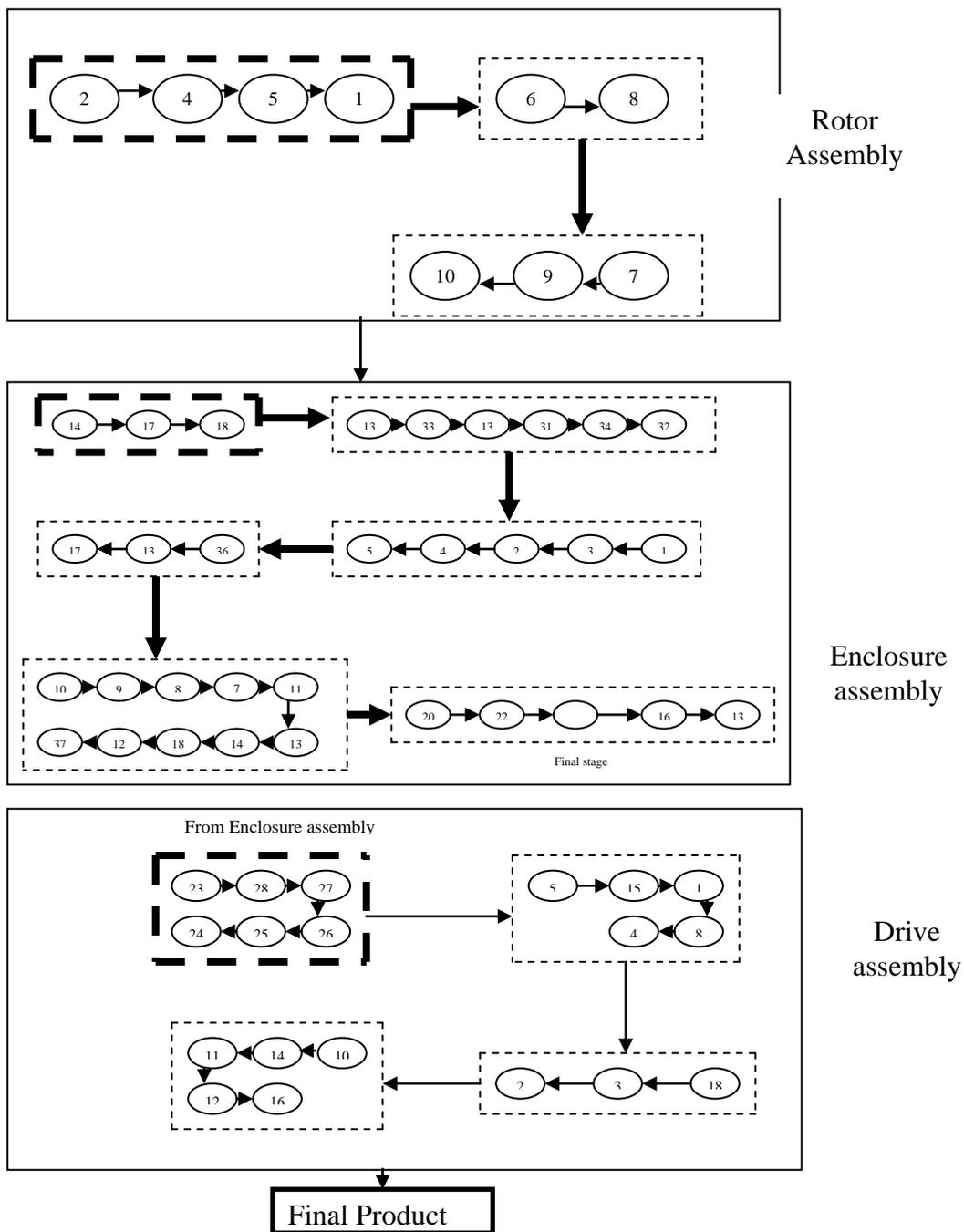


Figure 1: Precedence diagram for Chipper assembly

3.2. Design Facilities and Tools

Product layouts are designed to accommodate the parts and materials in a workstation. Such layouts are designed to allow direct material flow through the facility for assembly process and material handling. This section discusses the design of tools and facilities needed for each workstation.

a) Design table for rotor assembly:

Layouts and arrangement were determined. The designed steps are not easy and several considerations need to take into account before the table design is finalized. The dimension of the table is selected to be 900 mm × 1000 mm to provide flexibility for the assembly workers to reach the parts in a comfortable manner. Additional rod and hole is built to support the rotor horizontally and vertically during assembly process. This is to ensure the assembly process can run smoothly and effectively. Figure 2 shows

detailed and specification design of the assembly table is built. This design is to ensure assembly process must change and adapt quickly to the large amount of operations for each step.

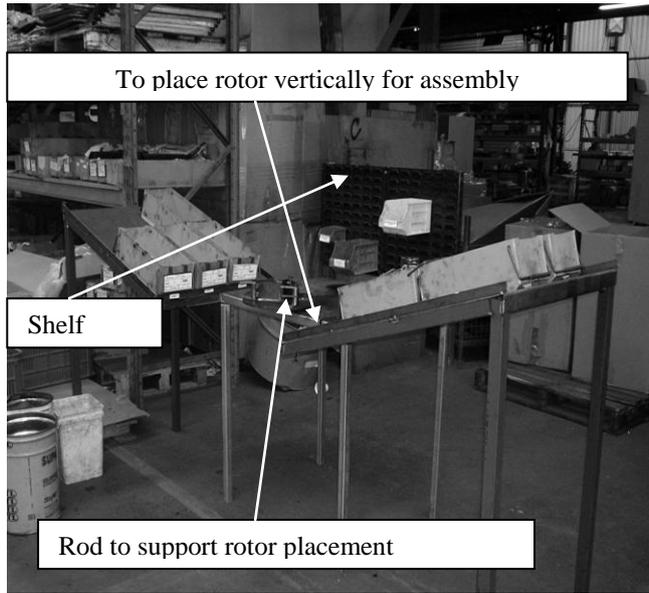


Figure 2: Table for Rotor assembly

b) Design trolley for hopper shedder:

The design of the trolley is used to accommodate storing and transportation for the hopper shedder and chipper chute. The wheel design uses two different sizes in each side (Figure 3). The reason for this is to allow the trolley to rotate so as to move in the limited space available. This is to provide flexibility and easy for production workers to take parts to the assembly process. The other purpose is to transport material from one department to work centre for processing parts. Figure 4 show detailed and specification design of the trolley is built.

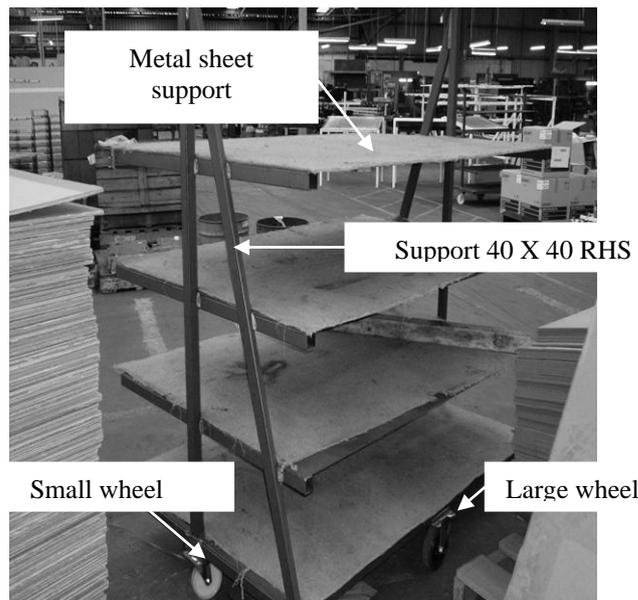


Figure 3: Trolley

C) Drive assembly:

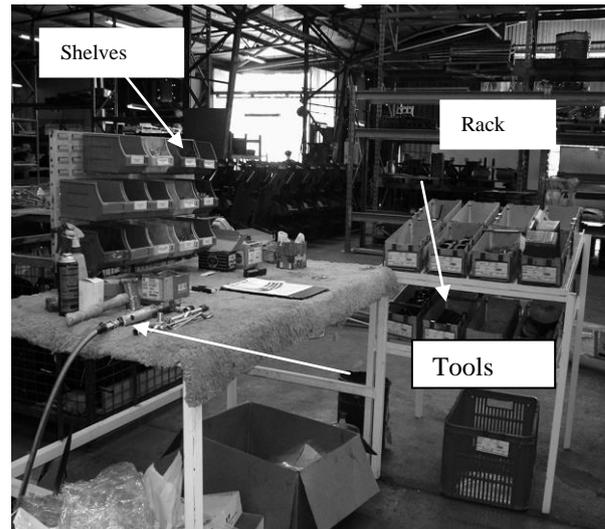


Figure 4: Enclosure assembly

After workflow and work method for the enclosure is determined, the compartment of placing all the material is designed as shown in figure 4. Additional shelf is build to support all the different sizes of bolts and nuts of the assembly. The shelf on the table supported by iron frame to accommodate small trays for consignment item such as bolts and nuts. These shelves are mounted on the table by using a mounting bracket welded to the table to accommodate the tools and components to simplify the process in enclosure assembly.

3.3. Balancing Assembly Area:

The objective of balancing assembly line is to assign tasks to the workstation so as to minimize the delay (total idle time) during assembly process. Initially the assembly for the chipper shedder needed three workers next to each other, with parts coming from different locations. After redesigning the assembly area, the assembly had three workstations. With the new task order, the number of assembly workers required was reduced to two. It was observed that the line was not perfectly balanced. The time required for each workstation was collected and analysed with the assistance of the preceding diagram. After further analysis, the workload and method for each station was revised to ensure balanced cycle time and labour cost were reduced significantly.

3.4. Implementation of Kanban:

After construction of the chipper assembly area, the next step was to implement the Kanban system. The first step was to identify the container used. Each tray had a production or move card. All the parts were counted and the quantity for each tray was specified for each parts. The Kanban system applied two card systems: production cards and move cards which carry instruction for each part. Each card controlled a quantity of parts which contained information to trigger instructions. Cards were returned to the production department after parts were consumed triggering production of the next batch. The number of the Kanban was determined by the time, cost setup, demand rate, and the number of parts that could be conveniently stored and transported. The next step was to specify stock points for each part.

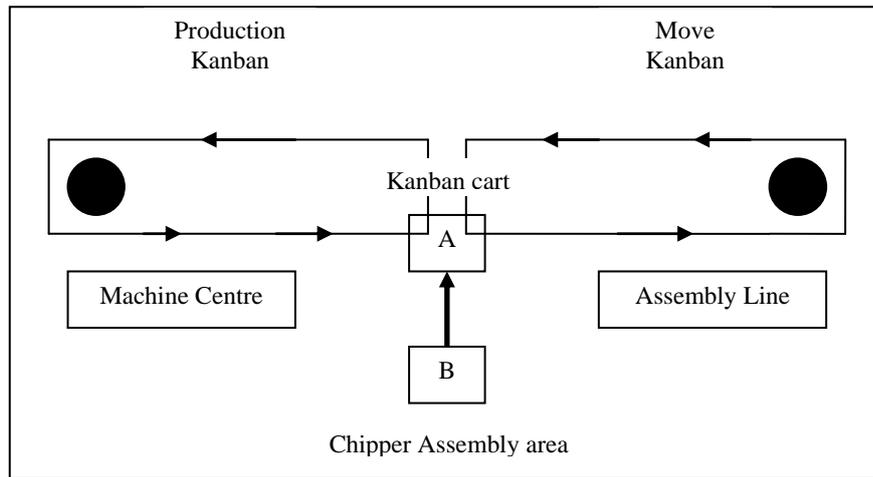


Figure 5: Flow of Kanban system at the Company

The standardised containers defined the lot size for the reorder point set. This approach also assumed continuous review of inventories predetermined reorder point, and fixed replenishment quantities. To reduce the number of idle parts, the batch quantity was kept as low as possible at the same time reducing space for storage. To assure the parts availability, the reorder point was set at the level that parts could still be available during the period of lead time. The last section was to design signal mechanism for the system based on plant layout.

Two trays were used for each material. If the first tray was empty, the workers automatically take empty box to Kanban cart. Card is removed from the tray and placed in the Kanban cart. The person in charge is responsible for work instruction based on information in the card to trigger execution. Production workers at work centre then authorise to make more parts. When parts are ready, the material is placed back on the Kanban cart. Move card specifies parts needed to be reordered based on information specified in the card. When production is completed and move item is ready, full container is placed at Kanban cart. Workers at the assembly line collect parts as needed.

4.0. RESULTS AND DISCUSSION

The table 1 presents the Company's achievements from implementation of Kanban in the Chipper shedder assembly area.

Table 1: Overall relative results

	Before	Now
Expected Time(s)	767	659
Labour hour/assembly	8	6
Total assembly worker	3	2
Max output/day	37	45
	High	Low

As a result of reconstructing the chipper shedder assembly area the required workers for the assembly is reduced by two. This allows saving in labour cost by 33 %. After balancing the assembly line, by

applying new task order the expected time to assemble one machine is reduced from 767 to 659 s. This shows the productivity is increased 14.08%. Unit cost per assembly is reduced from \$4.88 to \$3.69 with a savings of 24.38. This project resulted following benefits for the Company:

- Work in progress (WIP) in the line is reduced
- The number of faulty parts reduced in the system
- Machine setup time is reduced
- Production system is simplified with reduced bottleneck and streamlined material flow.
- Labour number and costs are reduced significantly.
- Productivity increased dramatically

5.0. CONCLUSION

The goal of the project was to implement Kanban system in the Chipper shedder assembly area in a leading Australian lawn care company. The company has achieved tremendous benefits by implementing the Kanban in the Chipper shedder assembly area. It dramatically reduced the work in Progress (WIP), labour costs, assembly times and total number of workers and it increased the output per day significantly.

There is still enough scope for future work in this area. Some of these are:

1. Detailed analysis of the cost effectiveness of the system
2. Fine tuning for number of Kanban and Kanban size
3. Ongoing projects for improving productivity and safety
4. Develop and document procedure to assist implementation of Kanban in other areas.

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