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Review of Kanban planning and execution in the context of Lean manufacturing

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Abstract

In this paper the various principles of Kanban planning and execution is illustrated with respect to cellular manufacturing, total quality management, total preventive maintenance and Engineering change management concepts as applied to Lean Manufacturing. A detailed investigation of Kaizen costing and cost analysis is also presented in this paper

1.Kanban Planning and Execution

1.1 Introduction

Kanban is a method for maintaining an orderly flow of material. Kanban cards are used to indicate points at which material should be ordered, how much material is needed, from where the material should be ordered, and to where it should be delivered. With IFS' Kanban solution, you can perform an advanced Kanban calculation using an actual demand profile to determine whether an inventory stock out is likely to occur with the current system settings. The system can calculate Kanban quantity or the number of Kanbans based on past usage of parts. You can recalculate and redeploy your Kanban circuits within a day when demand shifts IFS' Kanban solution lets you perform stock out simulations by retrieving demand from a variety of sources and for different time spans to determine whether you Kanban quantities are balanced You can use either visual or electronic signals for replenishment. Kanban replenishment can be from supplier, a sister plant, an inventory location, a location group or a production line. Options for demand type, Kanban formula, safety factor, signal type, and replenishment type let you adjust the use of Kanbans to best match your environment.

IFS' Kanban solution helps you maintain your Kanban cards. You can easily keep track of the number of cards used in the system, add or subtract cards during seasonal changes in demand, or print or replace cards

1.2. Vendor-Managed Inventory

Instead of sending Kanban signals to your suppliers, you can give them responsibility for and authorization to replenish goods. IFS' vendor-managed inventory capabilities and web-based portal technology make it is easier to collaborate with your suppliers. Instead of sending information back and forth, customers and suppliers can access inventory balances and future demands through a convenient portal, and the supplier can replenish stocks as required. The supplier can also use the portal to enter or search for information and update documents. The supplier becomes another application user, but with limited access.

1.3 Repetitive Production

With IFS' production scheduling functionality, you can perform order less, rate-based production. This reduces the number of report points, and simplifies and automates the production process. Final reporting of finished items is the only production reporting required, and all components are automatically issued (back flushed). You get reduced transactions throughout the flow, short cycle times, and less work-in process inventory. As a result, you can focus on ensuring enough material.

2.Cellular Manufacturing

Arranging operations and/or people in a U-shaped production line allows for better utilization of people and improves communication. Product flows smoothly from one operation to the next rather than running in a batch and then sitting in a queue at the next work center waiting for that operation to begin. IFS Applications™ lets you define an unlimited number of production lines, each with its own dedicated inventory storage area. Incoming materials are routed directly to the production line at which they will be consumed. Finished goods completed at the production line can be stored there until being shipped to the customer.

3.Waste Reduction

Waste is commonly defined as non-value-added activity. Lean practitioners identify seven types of waste:

• **Excess (or early) production**—producing more than the customer demands, or producing it earlier than the customer needs it. This ties up valuable labor and material resources that might otherwise be used to respond to customer demand.

• **Delays**—waiting for materials, tools, information, equipment, etc. This may be a result of poor planning, late supplier deliveries, lack of communication, overbooking of equipment, or erratic demand.

• **Transportation (to/from processes)**—Moving material more often than necessary. Material should be delivered and stored at its point of use. Why receivematerial at a receiving dock, move it to an inventory location, and then move it to the production floor when it can be delivered and stored where it is used?

• **Inventory**—storing more material than is needed. This wastes valuable space and cash. By reducing inventory, plans for warehouse expansion can usually be postponed or canceled.

• **Processing**—Doing more work on a part than is necessary, including inspection and reworking. This wastes time and money. Quality must be built into the manufacturing process so that parts are produced correctly the first time.

• Defects—Defective parts. Defects consume considerable resources. In addition to the original materials and labor used to manufacture the part, extra labor and machine time are required to fix the defective part. If the defective part is sold to a customer, not only will unnecessary shipping costs be lost, but more resources will be consumed to resolve the eventual complaints.

• **Movement**—Excess motion of employees in getting tools, picking parts, or moving from one point to another. This is usually the result of poorly planned work layout and workflow. A variety of techniques are available for reducing or eliminating waste. These techniques include value stream analysis, total quality management, total productive maintenance, Kaizen costing and cost analysis, engineering and change management, and document management.

4. Total Quality Management

Total quality management (TQM) is a management system used to continuously improve all areas of a company's operation. Quality functionality is integrated throughout IFS Applications. Failure modes and effects analysis (FMEA) is a systematic technique for managing risk in a manufacturing process. It involves recording and analyzing actual and potential problems with a product design or process, along with related solutions. This information allows you to improve accountability, avoid repeated mistakes, and improve the quality of the end product. Control plans can be defined to detail the measurements and tests performed at any operation of a shop order, production schedule, or purchase receipt. This helps to identify defects before any further value is added to them. Statistical process control (SPC) is a philosophy that emphasizes the use of statistical techniques, such as control charts, in all areas of a company to make continuous improvements in quality and productivity by reducing variation in processes. With IFS Quality Management™, you can create, view, and analyze X bar and R, X-bar and S, X and MR, np, p, c, and u control charts. IFS Applications also includes material review board (MRB) functionality for handling the disposition of defective material.

5.Total Productive Maintenance

Total productive maintenance capitalizes on proactive and progressive maintenance methodologies and calls on the knowledge and cooperation of operators, equipment vendors, engineering, and support personnel to optimize machine performance. IFS Maintenance™ is a world-class maintenance package that is completely integrated with IFS' supply chain management solution. Both maintenance and production workers have complete visibility into maintenance and production information and schedules. Operators can regularly perform preventive maintenance on equipment and tools, with maintenance personnel handling more detailed overhauls and repairs. The result is optimal equipment performance, including the elimination of breakdowns, a reduction in unscheduled and scheduled downtime, improved utilization, higher throughput, and better product quality. Bottom-line results include lower operating costs, longer equipment life, and lower overall maintenance costs.

6. Kaizen Costing and Cost Analysis

Unlike standard costing systems, a Kaizen costing system focuses on continuous cost reduction rather than simply meeting the standard and avoiding unfavorable variances. As part of the Kaizen process, you verify that the costing target has been reached and then continuously review existing production conditions to further reduce costs. In IFS Applications, you can set a cost target, calculate cost gaps, and plan activities to reduce costs. Major cost reductions can be broken into smaller reductions for which separate activities can be created that are easier to handle. Each activity is possible to evaluate from a cost reduction potential and from an investment need.

IFS Applications also allows you to perform commonality analyses. If an item is used in multiple places, commonality analysis helps you see which components are common for different structures and whether they can be used for other parts to save money. Cost/value analysis helps you analyze the costs of a component or product in relation to customer value.

7. Engineering and Change Management

IFS Applications manages the changes a design goes through during its lifetime in two stages: During the Engineering Change Requests stage, all change proposals from the organization are registered. These change proposals might include fault reports from the service department, the design departments own improvements, or a recommendation from the purchasing department to change supplier material.

The proposals are analyzed and formally approved. Then, in the Engineering Change Order stage, the design change is planned and implemented. The product structure helps to define items and minimize the work involved in making modifications. When the work is finished, a new part revision is created.

8. Document Management

For most businesses, managing documentation is not an end in itself. It's an essential part of day-to-day operations—a way of ensuring that the right people get the right information at the right time. Mismanaging the flow of information can result in confusion, unnecessary delays, and costly errors. With IFS Document Management™, you get full control over your company's documentation so you can focus on the things that really matter: selling your products and services, keeping your plant and equipment in top shape, and meeting or exceeding your business goals.

A framework was created to analyze manufacturing systems and assess the impact of various practices on system performance. A literature review of Lean Manufacturing resulted in the discovery of significant gaps in two areas: (1) modeling the effects of implementing Lean Manufacturing using control theory principles, and (2) a design framework for building Cellular Manufacturing Systems and making the transition from traditional manufacturing to Lean Manufacturing. Work in these areas led to the conclusion that reducing the Order Lead Time until it is less than Tall, the allowable customer lead time for post-payment production, would yield tremendous benefits both for individual factories as well as for entire Linear Distribution Systems. To fill these gaps, a model was created which analyzed the dynamics of Linear Distribution Systems, and showed how Lean Manufacturing represents an opportunity to sidestep many previously insurmountable difficulties that arise as a result of producing to fill inventory levels. The methods for implementation of Lean Principles were explored, from prerequisites for Cellular Manufacturing Systems, to design and optimization of Cells, through exploration of the improvements in quality that are possible in Cellular Manufacturing Systems. A thorough a dissemination of the various contributions to Order Lead Time showed that changeover reduction, information flow, zero defects and cellular manufacturing are all indispensable in achieving the goal of OLT < Tall. Finally, conclusions were presented which show that achieving this reduction allows for production under an entirely new philosophy that completely eliminates capital investment in inventory.

The difficulties that companies face in today's marketplace are fierce: shifting customer demand, increasing variation in products and demands for perfect quality. Meeting these demands while dealing with complex distribution systems and multi-tiered chains of suppliers is better understood in light of system dynamics (Forrester [1969]) and finding ways to minimize their cyclical nature. The way to escape the pitfalls faced by aerospace companies today requires a redefinition of inventory and a new production philosophy which eliminates the need to produce based on forecasts, or to fill stock levels, and to eliminate rework and acceptance of non-conformances Lean Manufacturing is a term popularized by Womack, Jones and Roos [1991] to describe a method for production based on the Toyota Production System (TPS) (Shingo 1989, Ohno 1988). There is a tremendous body of literature available on the details of the TPS. The purpose of this thesis is to take the principles enumerated in the literature one step further and show how lean manufacturing can address the difficulties of aircraft manufacturing as a linear distribution system (LDS).

9.Cellular Manufacturing (CM)- Processing of parts or part families in a single cell, with no backtracking. Each part follows a predetermined part path, and is said to be trackable. Individual cells may be built around Group Technology formed part families or based on a single product line (which facilitates ABC methods). In CM the operators move independently of the part processing time. A cell processes a subset of the total operations in the production system. Cells process parts sequentially through a series of machines or manual stations, whereas a job shop processes parts in parallel processing through duplicated machines. A cellular manufacturing production system is network of logically linked cells (Cochran [1994]). Hence throughput of cells can be dependent on (a) a single machine's cycle time (the bottleneck), or (b) the speed of the material handler or operator.

- **Changeover Time-** The length of time a machine or processing area is down (not producing parts) in order to change over from one part type to another. It begins when the machine finishes producing the last part of type A and ends at the beginning of the production of the first good unit of type B.

- **Cost of Order Preparation-** The costs incurred by a factory in the process of receiving an order, releasing it to the floor and closing the order upon receipt by the customer.

- **Customer Lead Time-** The length of time beginning when a customer places an order and ending when the customer receives goods to fill that order. It encompasses the Production Lead Time plus the time required to transmit the order to the factory and the time to ship the product to the customer.

- **Defects vs. Errors-** a defect is a product or service's non-fulfillment of an intended requirement or reasonable expectation for use. An error is the result of improper processing of the part, which leads to a defect only when the part is inspected and fails. Thus, errors can be fixed before they become defects.

- **External Setup Operations-** Operations in changeover from one part type to the next which are done while the machine is still producing parts.
- **Final vs. Absolute Defect Rate-** the final defect rate reflects only the number of parts that fail the final inspection. However, the absolute defect rate is a measure of the number of defects for the entire process from start to finish (see Shingo [1986])

10. Flexible Manufacturing System (FMS)- A group of numerically controlled machine tools interconnected by a central control system. The various machining cells are interconnected via loading and unloading stations by an automated transport system. Parts are generally processed in parallel rather than serially as in a Cellular Manufacturing System. Operational flexibility is enhanced by the ability to execute all manufacturing tasks on numerous product designs in small quantities. However, there are often limitations in flexibility due to the hard tooling that is required for material transport and fixturing in each machining cell. Capital investment is very high as compared to a manned cell.

11. Group Technology (GT)- A part classification technique used to categorize parts according to one of two possible similarities: (1) part geometry, or (2) processing similarities. GT is generally used to create part families which can then be processed in single cell.

12. Informative vs. Subjective Inspections- An informative inspection yields information about a part, such as a dimensional characteristic. As a subjective inspection is a pass-failure inspection, the inspector must make a subjective judgment about the quality of a part.

13. Internal Setup Operations- Operations in changeover from one part type to the next which are done when the machine is stopped (is not producing parts).

14. Job- Work order; an order from a customer which comprises a fixed number of parts of a specified type.

15. Lot Delay- In batch production, the time spent while the part is waiting for other parts in the batch to be processed.

16. Lot (or Batch) Production- Producing parts in lots or batches which are greater than one part.

17. Machine Utilization- The ratio of time during which the machine is operating to the total time available. The operating time should only include time in which product is being produced (setup time is excluded).

18. Machine Cycle Time- The length of time required for a machine to process one part, not including loading and unloading time. It can be measured as the length of time beginning when the start button is pressed and ending when the part can be removed.

19. Manufacturing Lead Time- The length of time from the first operation for a given order until the entire order has been transported to the shipping area.

20. Order (or Production) Lead Time- The length of time beginning with receipt of an order from a customer and ending when product for that order has been manufactured and transported to the shipping area. It includes the Manufacturing Lead Time plus the time required to process the order and begin production.

21Process vs. Operation- The distinction between a process and an operation is not one of time scale; the two have different subjects of study. A process is a flow of *product* from raw materials to finished parts. Operations are the actions of *man*, or *machine*, and what they do to the product.

22. Process Mapping- A systematic analysis of a production system using Time Division Analysis to determine which operations are integral to a process, and which must be eliminated.

32. Processing Delay- The time spent while a part is in storage, either in queue behind other batches of parts, or waiting due to machine downtime.

33. Production Balancing- Efforts to make the processing time for a given part at each station in a process equal. In a perfectly balanced process, no stations will be idle when producing parts using single piece flow.

34. Production Leveling- Efforts to increase the product mix and decrease the batch size in a manufacturing system. In *Level Production*, assuming there is no variation in processing, at least one unit of each part type is produced each day.

35. Production Synchronization- Efforts to synchronize the start, stop and transport of product at each machine, station and process. In Synchronous Production, the upstream process produces goods at the same rate (or Takt time) as the downstream process.

36. Self (or Source) Inspection- Inspection carried out by the person (or factory) which produced the

product.

37. Single Piece Flow- A term describing the processing of parts in a batch size of one. The only processing lot size in which the lot delay is reduced to zero.

38. Statistical Quality Control (SQC)- The application of statistical techniques to control quality. Generally refers to monitoring or inspecting some percentage (less than 100%) and inferring the quality of the rest of the parts from a sample. SQC is subject to and errors.

39. Successive (or Post-receipt)Inspection- Inspection by a person or factory of goods that were produced at an upstream station or plant. Traditionally thought to be more objective than self inspections, since there is no incentive to pass defective parts through the inspection. However, this inspection method can only discover defects after they have been made (see defects vs. errors).

40.System- A regularly interacting or interdependent group of items forming a unified whole toward the achievement of a goal.

41.Takt Time- A production rate determined by customer orders (or sales) which specifies the interval of time between production of successive parts. Is determined from the following equation: total time available for production per shift (in sec) Takt Time = required number of parts per shift

42.Time Division Analysis- A technique similar to process mapping where a process is analyzed by tracking a part as it flows from raw materials to the finish crib and constantly specifying whether a part is being processed, transported, stored or inspected. Storage is further broken down into Lot delay, Transportation delay, and Processing delay.

43. Transportation Delay- The time spent waiting for the means of transportation (i.e. waiting for a

forklift)

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44. Value Added vs. Non Value Added Processing- Value added processing refers to processing steps that will add value to a part, viewed from the eyes of the customer. Non value added processing includes all processing that does not add value. Thus a cutting operation on a machine is value added processing only if it creates a feature in the part that is of value to the customer.

45. Volume vs. Part Types Flexibility- Volume flexibility refers to the ability of a manufacturing system to produce parts at different rates. Part type flexibility refers to the ability to produce a number of different part types in a given period of time.

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