Design & Development of Collaborative Workflow for Lean Production in a Repair & Overhaul Industry

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Abstract: - Aerospace fuel nozzles maintenance, repair and overhaul operation is a dynamic process as the work flow is unpredictable. Further detail checking and analyzing on defects are needed in order to determine the workflow. The traditional paper based of work in progress information had been implementing as to manage the nozzles production. However, paper based of work in progress information is inefficient in dealing with these unpredictable and complex workflows. There is a probability of entering or recording the error information when it is in paper based system. This wrong information will cause problem in production line as the results are inconsistent. Furthermore, this inaccurate result will lead to difficulty in tracking the nozzles. Excessive time is needed and wasted in indentifying and correcting the errors. Hence, an electronic based of work in progress system is apparently required as to overcome the shortcoming of the paper based tracking and also to enhance the efficiency of production line. This paper will describe the configurable and customizable work in progress tracking system as a mean to improve over the traditional paper based system.

Key-Words: Work Flow, Configurable, Tracking System

1 Introduction

The maintenance, repair and overhaul (MRO) of aerospace fuel nozzles is a part of aircraft maintenance, repair and overhaul industry. The purpose of this MRO industry is to fix and repair any sort of mechanical or electrical device which is out of order or broken. In this paper, the device to be maintained is the aerospace fuel nozzles. Maintenance, repair and overhaul operation of the fuel nozzles is a dynamic process. MRO activities such as testing and repairing will be carried out with the intention to retain the defect nozzles. The repair activities can be different based on the nozzles condition. Different activities will be carried out in different stations. Therefore, the status of the nozzles will be updated each time the activities finished. These updates will ensure the proper operation and maintenance of nozzles and also to enable the company to trace the status of the nozzles. Hence, the accurate information of the nozzles is vital as to enable company to track the nozzles efficiently and avoid errors in production line.

According to [1], the importance of work in process (WIP) for capacity requirement planning had been highlighted. Accurate work in progress information is definitely needed for the capacity requirement planning as to improve the production line performance. Hence, lots of optimization techniques such as Classical Planning, Hierarchical Task Network Planning and Decision –theoretic Planning had been proposed. However, based on [1], these techniques only focus on the optimization aspect of the process and assume that all the relevant information is available. It also mentioned that obtaining the WIP information is not as straight forward and therefore a real time WIP system in production line is suggested as to enable company to have real time control of their production process. Literatures above had shown the importance of WIP information in production line. With real time WIP, the company is able to manage and control the production flow efficiently. This paper will discuss a study done for an MRO company which intends to implement a WIP tracking solution. In this paper, a solution of implementing real time WIP tracking system will be discussed as for overcome the shortcoming of the previous paper based WIP information.

1.1 Motivation

A generic work flow diagram which indicates operation of the MRO company we studied is shown in Figure 1. The operation of the company starts by receiving the incoming product, nozzles. When the nozzles are received, paper travelers will be generated and issued. These paper travelers that carried the product order information will route throughout the entire production process. The main production processes are Repair, Overhaul and Checking and these processes will be carried out in different work stations. During the production process, when a defective part of the product is identified, the part can either be scrapped or reworked. When the defective part is identified, another documentation which records the distribution of the products to or from the production flow, called MDR will be issued together with the original paper travelers. After the defective part had been inspected and analyzed, a rework traveler will be issued and the nozzles that had been diagnosed which will then enter again into the main work flow for further processing. Finally the last process is to handle and export the finished product.

Problem occurs during the production process as each operators need to manually update the status of the product by handwriting. The total amount of the processed product is actually recorded as each time the production process carried. However, based on the production work flow, the defect product will have to move to another process either reworks or scraps, which also means the products work flow, is alternative. Therefore, calculation of the total amount of processed nozzles needs to be performed by the operators. This will be increased the probability of recording the false information due to error in calculating and wasting time as the operator need to check their calculation and also need to ensure that they record under the correct processes. Therefore, a real time WIP information system is suggested as to enable the operators to record the WIP information efficiently. This will help the operators to be more concentrate in their main tasks rather than wasting their time on calculation.

Another issue that needs to be concerned is the status of the products. When there is a defective part of handling the nozzles with the same product order can

be scattered around different stations. This is because only the defective nozzles will be rejected or reworked until it meets the quality requirements while the other nozzles with the same product orders can move forward to the next process. Problem occurs when the company needs to trace the nozzles. It is totally inefficient as the company needs to track the nozzles by searching through each work stations. This situation occurred when there is no proper recording of the WIP information. Therefore, real time WIP tracking system is proposed as to overcome these problems.

2   Literature Review

Due to the advanced technology, RFID technology had been implemented in manufacturing industry as to gain visibility on its production floor and also control and monitor the status of the work in progress [1] and [2] had been using RFID technology in their tracking system. According to ABI research [6], *"MRO is Major RFID Opportunity for Aero and Defense"*. They predicated that RFID technology applies in Aero and Defense will reach $2 billion in 2011. This WIP tracking solution requires RFID tags and RFID readers as to perform the data collection and updates. The RFID tags are used to attach on the products. This RFID tags contain the product information which can be scanned and transmitted into the RFID reader. However, RFID technology is not suitable in our research as our product; nozzles will be going through operation such as chemical testing where the RFID tag can be damaged under this condition.
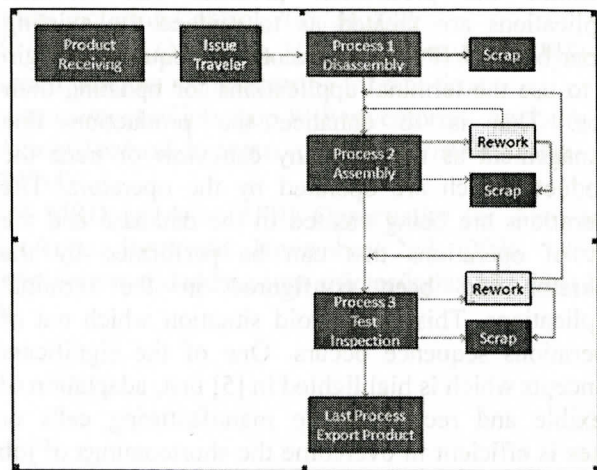

Figure 1 Generic Work Flow of MRO Operation

3 Proposed Solution

Real time WIP system is being proposed as to provide the view of the updated products information in production line and the most importantly is to enhance the management of the process flows. Real time information is an important as it reflects the real situation of shop floor. Management level will definitely need the updated and accurate information from shop floor as for their decision making of operations and manufacturing control. The importance of operation management and the decision support system for manufacturing control are discussed in [3] and [4]. Hence, the actual performance and the updated WIP information are needed for the operation management. The realization of real time management of shop floor WIP is greatly discussed in [1] and [5]. However, they are implementing RFID technology in order to achieve the real time WIP tracking. Rather than RFID technology, we proposed an affordable and an efficient approach to replace the paper based manual WIP tracking.

In order to enable the users to access the accurate WIP information, WIP terminal application is suggested to be built strategically in the selected workstation. Currently, the operators need to proceed to a board in order to update their job status. With the terminal applications reside in their work station area, it will create a convenience working area and also help to optimize the production process. The terminal applications are created as to replace the existing paper based WIP. The operators are required to login as to use the terminal applications for updating their jobs. This is to enhance the production line management as the company can view or trace the products which are operated by the operators. The operations are being created in the database and the list of operations that can be performed by the operator had been configured in the terminal applications. This is to avoid situation which out of operations sequence occurs. One of the significant concepts which is highlighted in [5] that, adaptation of flexible and reconfigurable manufacturing cells or lines is efficient in overcome the shortcomings of job shops. Hence, flexible and configurable concept is adopted in our approach as to meet the company requirement changes and its growing business needs.

The company's product, service, model, process or operation will be considered and required to be configurable. In order to achieve the configurable of the list, configuration management is released to the authorized employee. Figure 2 below shows the configurable list that is being developed in web based system.
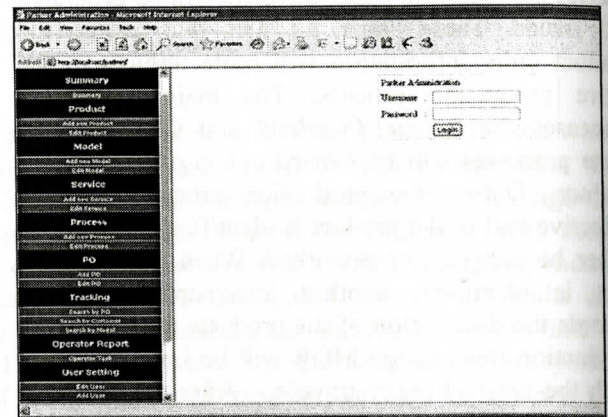
Figure 2 Administration Web Page

As to provide the real-time WIP information, data consistency is important. All the data that is updated via the terminal application is directly updated to the database. This is to ensure that every employee is viewing the same pieces of information. This information is crucial in providing the updated reports. This updated information will ease the tracking jobs. As mentioned above, when the products need to be reworked or scrapped, the product with same product order will be scattered in different stations. Hence, based on this real time information, the rework part can be easily and quickly located without going through station by station. A web based application is proposed as to enable the employee to track the nozzles status. It is customizable where the nozzle can be searched based on product order, model number, part number or customer order. Alarm is the indication for tracking each task or process is in schedule.

The purpose of this proposed real time WIP tracking is to allow the employee to trace the status of the specific nozzles as to report to the management level or customer. This also shows that the management levels wish to predict and ensure that the products can be delivered on time. Therefore, another alarm application is being suggested as a solution for this challenge. Alert will be generated and send to the

management level and operator as a report for follow up. The operators also can choose the urgent product to process first as to avoid late delivery to customer.

4 System Development

The real time WIP tracking system had been developed using client-server architecture. A minimal database and code maintenance is required in developing this system. An open source Mysql database had been chosen to reside at the server while the client program was written in Microsoft Visio Studio .Net in C# language. The primary database table design is shown in Figure 3. WIP_PRODUCT_# table is dynamic created based on the Product table where each of the products will create a separate WIP_PRODUCT_# table. For example Product with product id = 1 will have WIP_PRODUCT_1 and respectively. Process fields for each WIP_PRODUCT_# table will refer to the Product Process table. Dynamic creation of WIP_PRODUCT_# enables the system easy configurable and customizable especially for non-IT user. Configuration can be made easily via web configuration management system.

Figure 3 Database Table Design

5 Conclusion

Real time WIP information is vital in MRO operation as for advanced monitoring, analyzing and reporting purposes. This paper had been discussed the problem of the conventional paper based WIP in the company. The main problems are the traditional way of updating the WIP that is prone to errors and the difficulty in tracking the parts due to rework and scrap. Therefore, the real time WIP tracking system had been proposed as to meet the challenges of the dynamic work flow and to overcome the shortcomings of the conventional approach. System development and implementation had been further discussed in this paper. With this proposed system, the WIP information is updated efficiently and accurately. Since, the WIP information can be accessed immediately; real time monitoring is enabled to ensure the production line performance.

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