# Simulation of Real Time Tracking System Using RFID Technology to Enhance Quality Activities in Flexible Manufacturing System

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*Abstract*— **Flexible Manufacturing System (FMS) attracts industries to adopt it for its high productivity and flexibility. Recent improvement of FMS focuses on real-time tracking to ease planning, control and inspection to final product. One of the potential tools to be used in tracking, monitoring and controlling the final products is the Radio Frequency Identification (RFID) technology. Implementing RFID will lead to lower cost and high efficiency. This paper simulated a real-time tracking system using RFID technology to enhance and track the quality and inspection activities in FMS using Colored Petri Net (CPN) method. The proposed system suggests using RFID tags on base that carries the parts to be processed in the manufacturing system rather than putting the tag in the parts themselves. RFID Read/writes capability have been assumed in the model. Therefore, updating the data during the process will be adapted, such as reference number and updated status of part in further stages in the system. This gives a chance to use the base with tag again after accomplishing all required operations in the production system for other parts. Thus, this method helps to reduce the required cost for manufacturing. The simulation of the system using CPN tool shows that parts can be tracked successfully and provides more enhancements for production.**

***Keywords- flexible manufacturing system, RFID, quality management system, colored petri net***

## I. INTRODUCTION

The RFID technology has been used since 1970s in supply chain management. Beyond 2000s, RFID technology is considered as a significant tool to improve the material handling systems in production environment. Increasing level of technology in production area may increase the performance and productivity. One of these technologies is the RFID technology. The RFID implementation has been through certain level of utilization. It is mostly used in product tracking in the production line such as the pallets, cases and item tracking. The most cited one is pallet level tracking. RFID also has been used in container tracking part and work in progress tracking which is most likely in manufacturing industry. RFID is not yet used for asset tracking internally, reusable assets tracking in the supply chain and employee tracking. However, it is still under consideration [1].

The RFID application can be classified into four types which are automation, assertion, synchronization and innovation [2]. Automation is usually applied internally and involves a few RFID readers. Thus, it is considered as the simplest RFID application. It allows automatic capture of item identity. Besides, assertion is tracking an item by associating the identity with its location. The information tracked is shared among the partners. Synchronization is keeping a record of the event time. The complex one is innovation. It occurs when RFID is used to develop a new way of doing business [2]. Using RFID technology in production environment especially in complex manufacturing lines will help in reducing this complexity and may increase the tractability for the parts inside the production line. One of the most complicated manufacturing lines is the flexible manufacturing system (FMS). They are many types of flexibility in manufacturing system such as, machine flexibility, production flexibility, mix flexibility, product flexibility, routing flexibility, volume flexibility and expansion flexibility. Manufacturing flexibility may have different meaning. Zhang et al. [3] define manufacturing flexibility as the ability of a machine to perform different processes and can be economic. Parker and Wirth [4] stated that the manufacturing flexibility is the ability of manufacturing system to make a whole of part types. Mix flexibility is the ability to produce specific parts using different materials (Browne et al., 1984) [5]. Mix flexibility also known as process flexibility, is compliant to the changes in product mix because of the use of shared resources and acts as a shield to protect the product against market changeability. The challenges of acquiring of FMS is that it requires a high cost investment so maximum resources utilization and lower production time and cost are required to shorten time for return on investment [6]. However, in the new manufacturing environment, the human and industrial manipulator is working together sharing a common workspace and production area. This interaction may cause a need for more flexible and efficient real time data in manufacturing. Modern manufacturing systems are highly complex with numerous interrelated jobs, processes, machines, robots, and humans. Real time data is one of the challenges when dealing with indoor localization. One of the potential solutions is by using Radio Frequency Identification (RFID) technology.

In this research, the simulation of using RFID technology in the flexible manufacturing system was conducted using colored petri net which is one of the effective tools in modelling and simulation in discrete events that is similar to the events in most of production systems.

Petri Net (PN) consists of three parts: places (P) that shows the condition, transitions (T) which indicates the events and finally the arcs (F) to link the places with the transitions. This can be represented by N = (P, T, F), where P and T are limited but not equal zero and $F \subseteq (P \times T) \cup (T \times P)$.

## II. Problem Formulation

In this research, the RFID tags assumed to be fixed on AGV equipment to avoid any conflict in reading for more than one tag at the same time. So the RFID tag will refer to the carrying equipment instead to each individual product. The colored petri net have been used to simulate the production line. RFID writes data in tag such as reference number and reads the updated status of part in further stages in the system. However, this simulation can be extended in future research to cover each individual part in the manufacturing system. This can be achieved due to the new technology of RFID sensors and the ability of the new readers to detect and track more than one tag at the same time.

## III. Case Study

Figure 1 represents a case study of three manufacturing stations with one quality inspection station using RFID tags. A part from Source will be transferred into the Base with Tag where then the RFID will write reference number in the tag for the part before it is sent to machines. Next, Machines 1, 2 and 3 respectively will perform processes on the part. Then, the quality will be performed to inspect whether the required specifications are achieved or not. The tag will be updated based on that and the data stored in RFID tag distinguishes the part as accepted or rejected one. Once all steps are done, the Base with Tag will be sent to first stage to be utilized again.

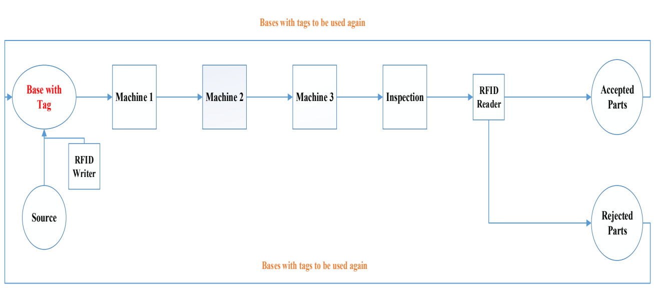


Figure 1. Manufacturing System Example

CPN tool was used to design the manufacturing system as indicated in figure 2.

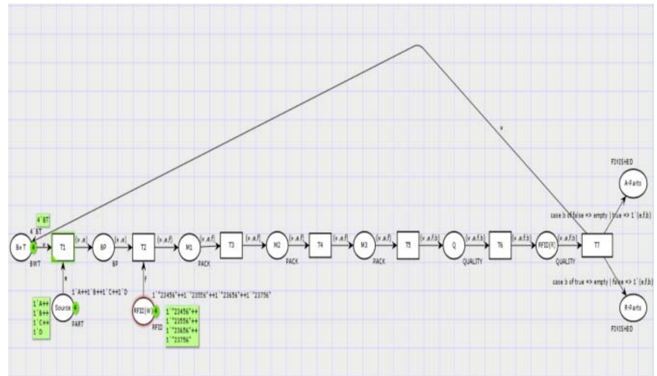

Figure 2. Design of the system in CPN

CPN model assumed the followings:

a. Four different tokens represent parts A, B, C and D in place Source.

b. Four tokens (BT) in place BwT denote to Bases with Tags.

c. Four tokens (23456, 23556, 23656 and 23756) in place RFID (W) for the references to be written in Tags.

The interpretation of places and transition is clarified in table I and II:

TABLE I. Interpretation of Places in CPN

| Place | Interpretation |
|---|---|
| BwT | Base with Tag |
| Source | Source for parts to be processed |
| RFID(W) | RFID Writer |
| BP | Base with Tag contains part from source |
| M1 | Machine 1 |
| M2 | Machine 2 |
| M3 | Machine 3 |
| Q | Quality and Inspection |
| RFID(R) | RFID Reader |
| A-Parts | Accepted Parts |
| R-Parts | Rejected Parts |

TABLE II. INTERPRETATION OF TRANSITIONS IN CPN

| Transition | Interpretation |
|---|---|
| T1 | Immediate transition of part to Base with Tag |
| T2 | RFID writes data in Tag |
| T3 | Machine 1 performs an assigned process |
| T4 | Machine 2 performs an assigned process |
| T5 | Machine 3 performs an assigned process |
| T6 | Inspection of part |
| T7 | RFID reads data from Tag and distributes part in accepted parts or rejected parts |

The simulation of the system starts by inserting the part in the Base with Tag as shown in figure 3.

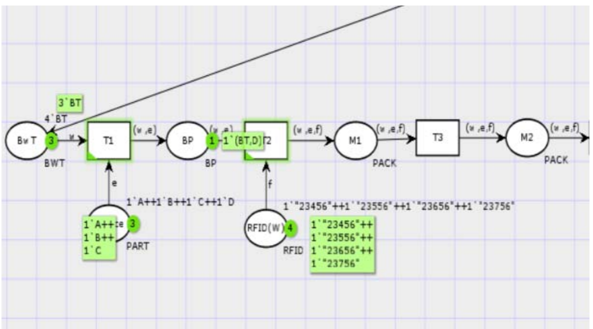


Figure 3. Part in BwT

Then, RFID writes reference number in the tag to distinguish the parts in the system.

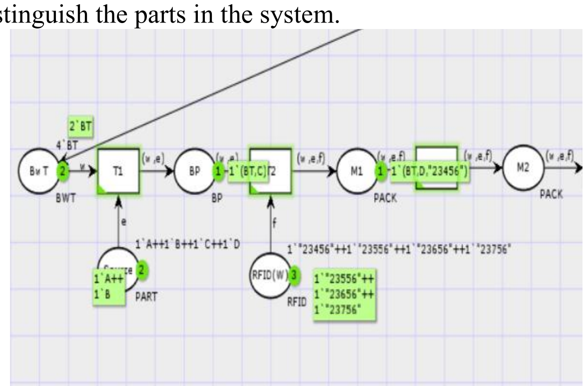


Figure 4. RFID writes reference number

The parts undergo to specific processes done by machine 1, 2 and 3 respectively.

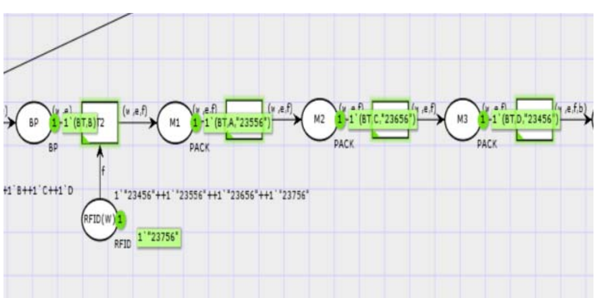


Figure 5. Machines preform process on the parts

Once the part reaches quality stage, it will be checked and determined if it is accepted (true) or rejected (false).

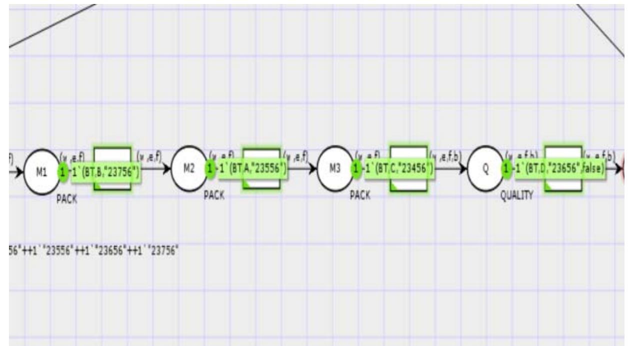


Figure 6. Quality and Inspection

Next, the RFID reads the data after inspection is finished to see if the data shows (true) to send the part to A-Parts, otherwise the part is sent to R-Parts.

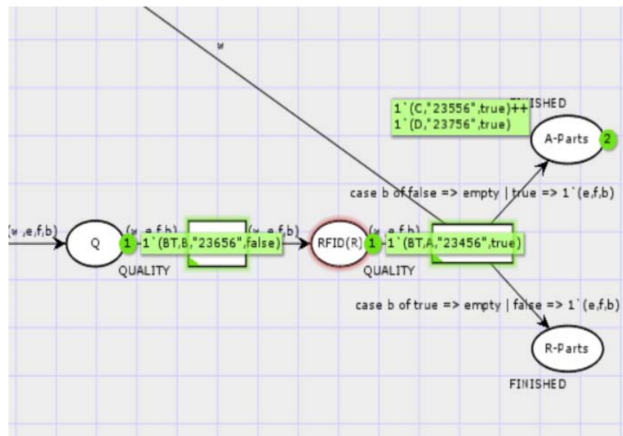


Figure 7. RFID reads data in Tag

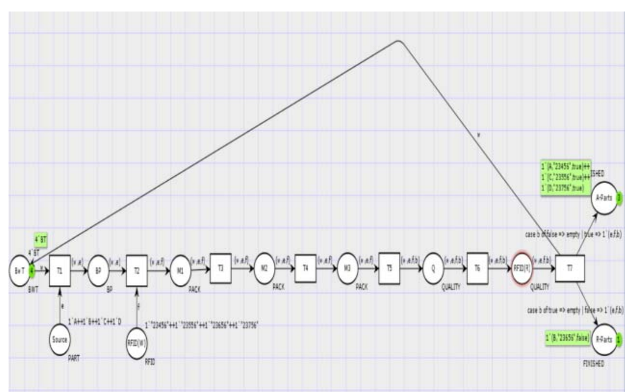

Figure 8. End of simulation

Figure 8 shows the end of system simulation with rejecting part B and accepting the other three parts. It can be seen that once each part is distributed in accepting parts or rejecting parts, base with tag is sent back to the beginning of the system to be used again.

## IV. Conclusions

In this research, a general understanding of using RFID technology in FMS was gained. Colored petri net has been used in modelling and simulating based on assumptions of using RFID. Assigning the tag on base rather than on the part is economic way to save costs by using the tag again for new part after finishing the current one. Using simulation techniques reduces the risk of any failure that may happen in implementing new technologies.

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