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Design of Manufacturing Information System using Advanced PLC and Server Controls

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Abstract-Modernized Control Systems like HMI/SCADA empower proficient administration of assets, continuous information investigation and control and information logging or chronicled data gathering. But with regards to exhaustive and basic administration of the assembling plant, the framework appears to be lacking. Manufacturing Information System is a recently created idea that empowers us to deliver the objectives like Poka-yoke, reverse traceability and unified monitoring for quality administration of the product and also industry. The framework gives tools and strategies to store and examine information crosswise over different production systems of the plant by organizing, synchronizing, archiving, and aggregating the data gathered in computerized or manual systems.

Index Terms-Manufacturing Information System(MIS), Tyre Industry, Tyre Traceability, MS SQL, Factory Talk Transaction Manager, Barcode Scanner

1. INTRODUCTION

Manufacturing Information System are computerized control systems used in manufacturing. It is targeted for use at any production location. The system works in association with other functional information systems to strengthen as well as support the industry's management team in solving problems that are related to manufacturing the products, and thereby tracks and documents the transformation of 'Raw materials to finished goods' [6]. Manufacturing Information System can be called in short, MIS. It is also referred as Plant MIS. The MIS handles plant floor integration from raw material warehouses till finished goods[2]. It interacts with the plant floor system to capture the appropriate production and process parameters which is required for value stream essential and genealogy tracking.

MIS helps to provide right information at the right time and give a picture on how the current condition on the plant floor can be optimized to improve production output. The system captures real-time data and help manufacturers to take action at that particular moment based on the information[5]. It manages and disseminates the recipe information to the value stream essential from a centralized system. Business rule interlocks are introduced to ensure mistake proofing. The system helps to generate necessary reports for business analysis and interface to the ERP system for mutual data exchange as required by the process automation within the industry. The created "as-built" record thus enables backward traceability of the manufactured product, mistake proofing and centralized monitoring. It acts as an intermediary between Enterprise Resource Planning (ERP) system, and Supervisory Control and Data Acquisition System (SCADA) [1] or process control system.

2. SYSTEM DESIGN

2.1. *Design Overview*

The main aim of Manufacturing Information System (MIS) are Poka-yoke [7], backward traceability [8] and centralized monitoring. To design the system, first we need to know the type of industry, what are various processes and equipments involved in the manufacture of product, different machine parameters involved, system interlocks as well as business-rule interlocks and inputs and outputs of each stage.

Designing MIS as a wholerequire several software environment. Here, for simplicity of understanding - MIS Database, PLC Logic, HMI Screen, Barcode Scanners and Network environment are explained. The aim of this project is to designMIS in a Tyre Manufacturing Process. Tyre is made up of sub-components and various child materials. To keep an end to end tracking of in-process mapping with relevant data, MIS is required.

2.2. *Design Architecture*

Fig.1 explains the network design architecture of MIS in each area. The various peripherals are interconnected within the system using a reliable and robust Ethernet connection. The tyre barcode is scanned using a wireless scanner. The barcode is the identity of the tyre. The data is send to MIS Server through a Wi-Fi access point and is mapped against Machine ID, Employee ID and Shift ID which the employee enters manually in the scanner or Machine

HMI at the start of the shift. The Recipe for production is chosen through the HMI screen of the machine. The Recipes are stored in the MIS database along with set machine parameters and is pulled out using the PLC.

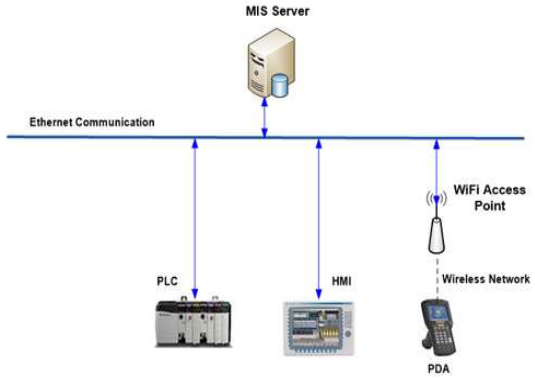


Fig. 1 Network design architecture

The running parameters of the machine are sent to the database through Ethernet. All the details obtained from machine are stored in database against the tyre barcode for validation purposes.

2.3. *Design Configuration*

Fig. 2 represents the schematic diagram of the MIS configuration as used in the tyre manufacturing process.

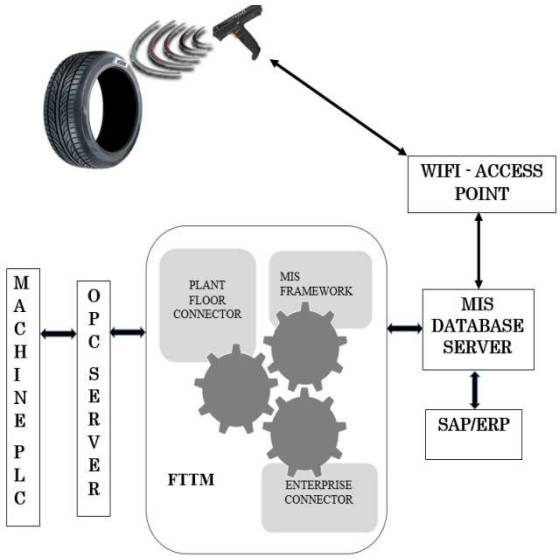


Fig. 2 Configuration of MIS

The data from PLC is interfaced to Factory Talk Transaction Manager (FTTM) via OPC server. The OPC server is used for server-client connectivity by means of driver. The OPC tool used here is KepServer Suite. FTTM is a software tool used to configure MIS Framework. It helps in one to one mapping between plant connector and enterprise connector. The data is ultimately stored in the database and used for tracking and decision making purpose[3].

The PDA device (scanner) communicates directly with the database via web service. The scanned barcodes are pushed to the database. Data can also be pulled from database to plant floor for necessary confirmations. Here, the scanned barcodes are sent to database through Wi-Fi for mapping against the data and thus enabling the feature of traceability. SAP/ERP is an enterprise system that communicates with the database for managerial decisions [4].

2.4. *Design Requirements*

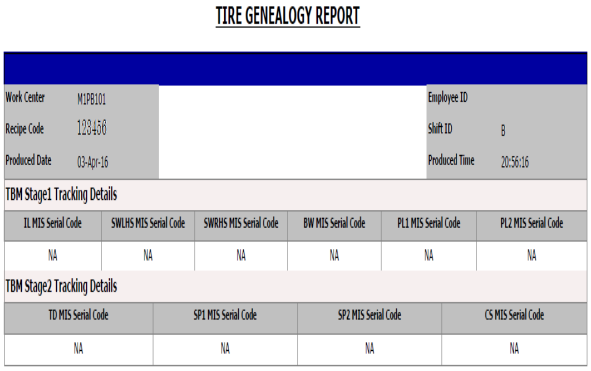
The various requirements in designing the Manufacturing Information System are listed out as follows.

- Step-wise study of the process.
- Study of process equipment.
- Knowledge of inputs/outputs and various process parameters.
- Controllers used in industrial equipment.
- PLC Controllers used in industrial equipments and their compatibility.
- Study of compatible Softwares that should be used for configuring MIS and their memory sizes.
- Selection of barcode scanner model and interface.
- Cost analysis.
- Selection of barcode labels such as material, print and sizes.
- Database memory.

3. IMPLEMENTATION OF MIS

When the tyre is prepared on the machine, the tyre barcode is scanned. At this moment, running parameters of the controller is captured through the network by OPC to FTTM and thereafter logged into the database. The logged data are mapped against the barcode and can be viewed using the web services. That is, the data is populated as a report and the report can be accessed from any part of the industry by anyone who has access to the site password. The report is accumulated with real-time informations. Thus an immediate access to tyre history is made available. It helps to connect all the pieces of manufacturing puzzle into one coherent whole, so that

one look at the big picture and everything would be clearly understood. Fig.3 is an example of Tyre Genealogy (Traceability) Report image file which is the final output or result of MIS.


TIRE GENEALOGY REPORT

Work Center	M1PB101	Employee ID	
Recipe Code	128468	Shift ID	B
Produced Date	03-Apr-16	Produced Time	20:56:16

TBM Stage1 Tracking Details

IL MIS Serial Code	SWLHS MIS Serial Code	SWRHS MIS Serial Code	BW MIS Serial Code	PL1 MIS Serial Code	PL2 MIS Serial Code
NA	NA	NA	NA	NA	NA

TBM Stage2 Tracking Details

TD MIS Serial Code	SP1 MIS Serial Code	SP2 MIS Serial Code	CS MIS Serial Code
NA	NA	NA	NA

Fig. 3 Example for MIS report format

It is able to know the machine in which the tyre or the tyre sub-component is made, the employee who has built it, shift ID, date and time of manufacture, the actual machine running parameters etc. from this one single file. The entire data is mapped against the tyre barcode. Each sub-components or the child materials are given serial numbers for identification. When a recipe is running in the machine, the detail of all the recipe parameters used in the machine are also made available in the report so that it helps in recipe validation which helps to increase efficiently in mistake proofing.

3.1. *Software Environment*

Rockwell's software is preferred to design the system since the machine controllers used are of AB PLC- RS Studio 5000 v.20. Hence the MIS Barcode logics were also developed in the same. After developing the logic, the file was downloaded into the controller. The barcodes and machine running parameters were taken from the controller and are copied into the database through the OPC server. PLC logics were developed accordingly. The information if not sent due to some down-time issues in server, it will be stored in the buffer memory and are later re-sent. The MIS system ensures that no data is lost. Factory Talk Transaction Manager (FTTM) is an industrial transaction software engine that enables data sharing between shop floor machines and enterprise applications. FTTM 70K tags is chosen on the basis of number of transaction. It can manage the transactions, which means that it can move large amount of data in fast and robust manner.

KepServer is the OPC connectivity tool used for transaction. It is a server-client technology which enables data transmission between multi-vendor devices and server applications. This OPC server ensures continuous communication among PLCs and the FTTM.

MS SQL server is a relational database management system developed by Microsoft. It is used for storing and retrieving large amount of data as requested by other software applications in the enterprise system.Table I illustrates the software environment used with respect to the operating system.

TABLE I. Software environment

Sl.No.	Software	Version	Operating System
1	Rockwell FTTM 70K tags	10.22	MS Windows Server 2008 R2
2	MS SQL Server	2012	MS Windows Server 2008 R2
3	KepServer Suite	5.18	MS Windows Server 2008 R2

3.2. *Barcode Label*

The MIS tyre barcode label used adopted the following specification. Table II represents the labelling of barcode.

Symbology Format: CODE 128
Dimensions: 37 mm X 8 mm (Width X Height)

TABLE II. Barcode labelling

Sl. No.	MIS Barcode	
1	Syntax	XXXXXXXXXX
2	Example	1612345678
3	XX	Year code 16 for 2016
4	XXXXXXXX	Running Serial number

3.3. *Workflow of MIS Barcode Scanning Process*

Given in fig. 4 is the work flow chart of MIS Barcode Scanning.

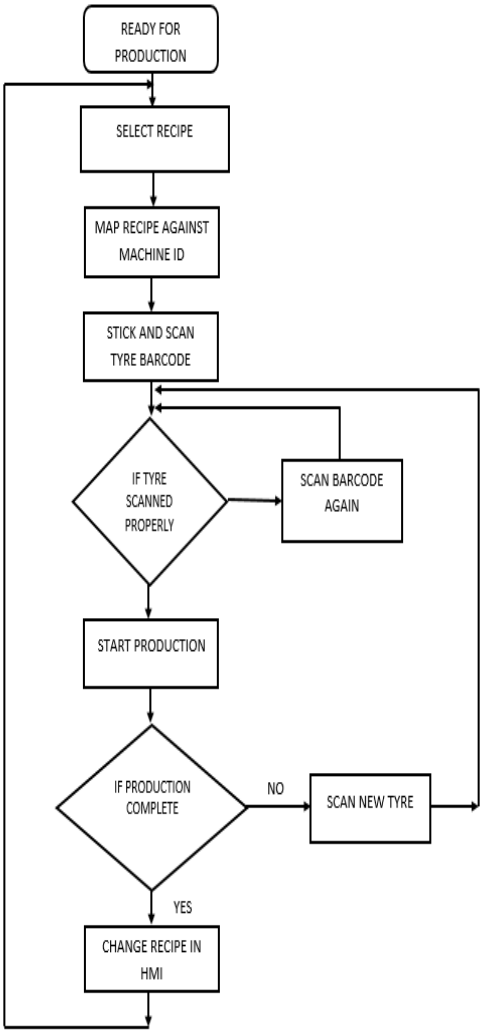


Fig. 4 Flowchart of scanning process

Select the tyre recipe in machine HMI. The recipe will be initially mapped against the machine ID. Place the green tyre on the machine with a barcode pasted on it. Scan the barcode. To ensure barcode scanning, an interlock is made in the machine using PLC logic. If barcode is scanned, only then the machine gives production count. All the machine's running parameters along with other reporting datas are mapped against the scanned barcode and are pushed to the database.

4. SCANNER SCREEN DEVELOPMENT

The scanner were developed using a software vb.net (Visual Basic 2010).

4.1. *User Login*

The user has to log into the system using his/ her employee ID and password. After logging into the system, those features that are assigned for the logged-in user will be enabled. Fig.5 represents the scanner user login screen where user credentials are to be entered.

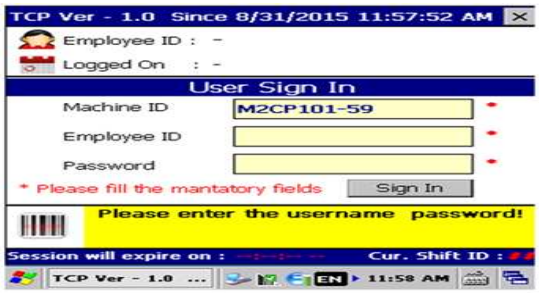


Fig. 5 User login screen

The user has to enter the machine ID, Employee ID and password manually. If the person enters wrong password, the following display in fig.6 appears on the screen.

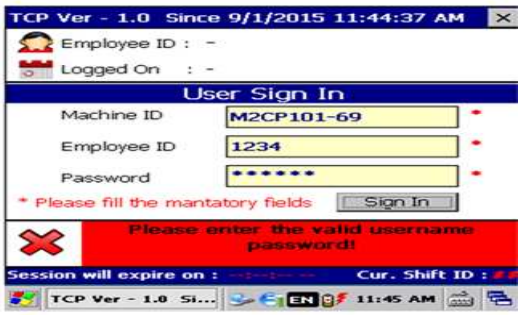


Fig. 6 Wrong user login

4.2. *Wi-Fi Communication*

Fig.7 shows the scanner communication problem when Wi-Fi communication is not established properly.

Fig. 7 Communication failure

5. HMI SCREEN DEVELOPMENT

The HMI Screen were developed using software FT View Studio version 7.0. Fig.8 represents the HMI screen for MIS communication.

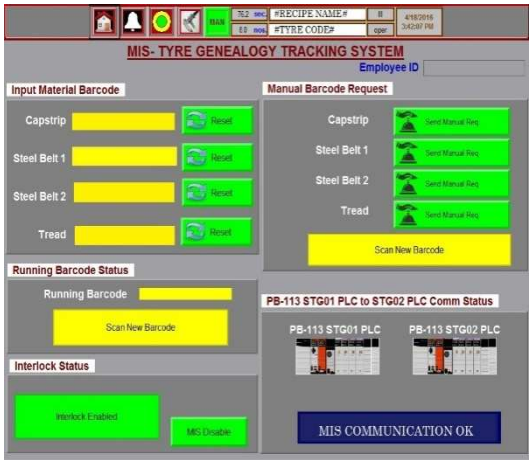


Fig. 8 HMI screen for MIS communication

All sub-components and child materials required for assembly of a tyre are assigned either serial numbers which can be entered manually into the HMI Screen or by scanning under Input Material Barcode. If there is any break in production due to problem with the components, either wrong serial number or finished usage, it is possible to send a manual request to the respective areas through the HMI for the required material. The communication is sent through Ethernet to the MIS Database and thereby alerting the respective shop-floor area. This allows faster communication and immediate delivery of materials which will speed-up the production process as well ensures mistake-proofing.

6. RESULT

The final result of MIS is the accumulation of data in the database which can be accessed anywhere from the plant organization who have got a personal username and password. Both area-wise production detail and final tyre production count can be viewed using the SQL server. The files can even be downloaded in excel or pdf format for further requirements.

6.1. *Area-wise Production Detail*

Each sub-component used to build the tyre are given specific identification codes which are entered into the HMI screen manually or by using scanning facility before production. It also displays the work center ID, Recipe code Production code, shift and employee details.

An example for report-file showing the format of current running recipe of tyre assembly running on a particular machine at a timeis shown in fig.9.

TIRE GENEALOGY REPORT

Work Center	M1PB101	Employee ID	
Recipe Code	123456	Shift ID	B
Produced Date	03-Apr-16	Produced Time	20:56:16

TBM Stage1 Tracking Details

IL MIS Serial Code	SWLHS MIS Serial Code	SWRHS MIS Serial Code	BW MIS Serial Code	PL1 MIS Serial Code	PL2 MIS Serial Code
NA	NA	NA	NA	NA	NA

TBM Stage2 Tracking Details

TD MIS Serial Code	SP1 MIS Serial Code	SP2 MIS Serial Code	CS MIS Serial Code
NA	NA	NA	NA

Fig. 9 MIS Current recipe running status

6.2. *Final Tyre Production Count*

Fig.10 represents the report of total production count of different types of tyre built in a day in the plant. This report helps to know the market demand of the tyres and its analysis.

Sl.No	Tyre Code	PCount
1	1########	5146
2	2########	6192
3	3########	3198
4	4########	1733
5	5########	5632
6	6########	6052
7	7########	1783
8	8########	5972
9	9########	2982

Fig.10.MIS production count report

7. CONCLUSION

The proposed system brings a clear idea in how Manufacturing Information System helps tracking, defining business interlock, traceability and real-time data capture.

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