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Manufacturing Automatic Data Collection

A Capstone Project Report

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Abstract

The question or purpose of seeking out new technology and actively using it is whether it makes our lives better and more efficient. Today's state of the art manufacturing facilities and even the ones that are slightly behind the modern curve, have manufacturing processes that produce an enormous amount of data that needs to be captured; Futaba Indiana of America (FIA) is currently not using autonomous data collection measures on their production floor. If FIA's data was collected and properly utilized it would provide valuable information, which could aid their organization in making business decisions and help to lead them into a significant competitive advantage.

Unfortunately, if a facility's automation development is lacking in the field of equipment network capability, it can make it quite challenging to collect and capture all of its relevant data. Understanding the purpose of automated data collection and trying to move into the age of "real-time" machine data collection is all about helping your facility improve productivity and profitability. However, it is also about making the essential first steps toward becoming a data-driven, high-tech manufacturing sector that makes the company internationally competitive.

FIA, in short, will begin this journey to becoming a smart manufacturing facility by implementing the following tasks: upgrading internal server capacities to handle the intense data load, upgrading all equipment PLCs for network capabilities, running network cabling to all equipment desired to be "on network" and create a PLC program to capture all the desired manufacturing data. The goal at the end of this project is to make data collection effortless, done completely without the need for a production control specialist to count a single part on the plant floor.

Outline

Introduction

We are living in an era where every transaction performed is completed and looped back to a database in just milliseconds; this instantaneous feedback loop has created the ability for continuous monitoring, of any metrics that has significant importance. Manufacturing production data is a key metric that needs to be collected and monitored to achieve the highest results possible.

The current process at FIA requires production team members to write down production data at the end of each two-hour production rotation, and then compile all numbers at the end of the production day for each production cell location. This method has many flaws including the following: human error factor or inaccurate production data, manual manipulation or bias recording of production data, and expense for the time requiring team members to collect production data. Due to the repeated occurrences of inaccurate production data recorded, production control specialist are required to conduct plant inventory counts each morning to ensure accurate inventory levels; having to do these activities also increases the delay time for production to know their daily targets. Production Control (PC) analysts take these production numbers and record them into Legacy (inventory software system); at the end of each yearly quarter, FIA performs a quarterly inventory to confirm PC's inventory levels. Without a doubt, every quarter the numbers are off, which questions the team members, the system and the process.

FIA analyzed manual data collection records over a two-month period, and realized how inefficient their current processes are. (Figure 1-8) After evaluating the inaccuracies and considering the benefits and abilities of an automatic collection system, FIA has made the decision to research and invest in an automatic data collection systems.

The belief is that automated data collection just saves time. In today's lean manufacturing environment the demanding consumer requirements leave no room for waste; automated data collection is a concept with a purpose to streamline data collection to the point of effortless utilization of resources once completed. One solution could be to create a program dedicated for capturing data, while interfacing with Programmable logic controller (PLC) programs and Human-Machine Interface (HMI) modules; these PLC and HMI units are already in operation on the manufacturing floor, thus making the process very efficient.

Programmable logic controllers (PLCs) are special computer devices, which serve a function in a variety of settings; most importantly in our case, the manufacturing environment is one where there existence is very common. PLCs have played a major role in manufacturing, acting as a bridge to connect field devices together; PLCs have become a very useful tool for Supervisory Control and Data Acquisition (SCADA).

PLCs in their origin were merely a replacement for relay banks in the industry; they have evolved into a powerful tool, probably more than we could have imagined they would. As technologies have developed over time, so have the functions and uses of PLCs. From simply an on/off relay array, to math and arithmetic functions, and to the point that PLCs are sometimes the entire brain of an automated process line. PLCs operate on a local level, down to the field devices; this allows users to interface with them directly, make changes and not affect the data collection system as a whole.

To reiterate the original question asked above, does seeking out a new technology and actively using it makes our lives better and more efficient. PLCs are not a new technology in the industry, but using them with new technology can make our live easier. PLCs provide a possible avenue to connect floor applications with modern technology, in order to capture all that important information.

Problem Statement

FIA is currently not using any means of automatic identification and data capture (AIDC) practices at their facility; they are many years behind current technologies, which forces FIA to collect their production data using manual collection methods. These manual collection methods are causing inaccurate inventory levels and thus require rework for production to maintain correct production values; these manual methods are also not efficient or conducive to the production team's time, and require production control specialist to recount inventories for finished good part numbers each morning.

Significance

Many manufacturing companies are facing the realization that their sector is only getting more competitive, and the need is rising to secure their contracts. Companies are trying to better understand ways to minimize downtime, create longer equipment overall availability (OA) and higher equipment overall efficiency (OE). Automated manufacturing facilities have already staffed their teams with highly skilled technicians for troubleshooting and repair of equipment related breakdowns and their skills are utilized to advance the company's agenda in making strides to become a data driven company.

An ideal approach for any company is to invest in an Automatic identification and Data Capture (AIDC) system. Annabel Maw is a Marketing Communications Manager at JotForm and stated the following about data collection, "Manufacturing companies are realizing the importance of data collection and analytics to remaining competitive in the industry". Manufacturing executives and managers can use this real time data to assess historical process information, identify areas of concern for correction and optimize those areas in the processes that are not performing at the highest possible efficiency. After FIA develops an (AIDC), they will be able to use real-time, shop floor data to access their areas of needed improvement. This case study will provide valuable information for FIA and others looking to develop their own internal automatic data collection system in a similar manufacturing environment.

Literature Review

In one way or another, everyone is today's society are all bound by some type of data. Whether it is internet-based data, some type of smartphone gadget or a software that measures and tracks important information. The whole's concept of "data" has infused itself into the very fabric of your lives and is somehow now an extension of who we are and what we have become. "Data stored on paper no longer has the right to exist", summarized best by Staniszewski, Legutko and Raos in their article "Production Data Collection, Exposure and Analysis" [9]. Without a doubt, nobody understands the reality of data flow more fluently than the individuals that make their living in the world of manufacturing.

According to the Wintriss Controls Group, manufacturing companies have been collecting data using manual methods for years, and have endured the struggles of these outdated practices; they state that "There are many opportunities for inaccuracies to creep into a manual data collection system." [10] Manual data collection methods are full with issues that compromise the data that is collected. These old data collection methods are not timely considering they are normally assigned to a factory floor worker, with many other obligations and will neglect data collection for the last step. Manual data collection is also regularly inaccurate, because that this method requires the data be written down by one person, and then recorded later sometimes by another person. Finally, a major problem with manually entered data is the biasness of the recorder; Wintriss article states, “Whenever a human operator enters data, he or she has influence over exactly what information is entered and when it is enter.” [10]

Individuals forget that the industrial landscape of manufacturing has been around for a couple hundred years now, going back to the original industrial revolution. Here in the US, our latest reiteration of this reinvented process is being noted as the fourth industrial revolution, or has also been called “The Forth Age” and “Smart Manufacturing” [1][12].

Today, smart manufacturing is simply being able to digitize all manufacturing activities and have the ability to rapidly, convert this information into usable data. This is according to (Journal of Big Data, 2019) [8], stating that all big decision in a company are made using data collection from that specific industry. They go on to state in their articles, that process data analysis characterizes the manufacturing processes into a hierarchy of structured, well selected data; this same hierarchy was noted, but termed differently by Jasperneite and Neumann (*Measurement, Analysis… Communication Systems*) [7]. All of these sources reference how data flows from bottom to the top in the following path, making up what is known as a facility ecosystem: Field/Device Level, Control/Cell Level, to Enterprise/Plant Level.

Advances in today’s technology have made organizational ecosystems bottomless, fully integrated with multiple dimensions designed to effect all aspects of a company. Facility ecosystems primarily consist of the following layers [4] [8]:

- Data Sources (Layer 1): This is the lowest layer and is comprised of tools that produce data for the ecosystem; these data sources have a wide range consisting of design and diagnostic tools, to physical sensor and devices.

- Life Cycle (Layer 2): This layer is comprised of all the areas that consume and interrupt information from the data sources. Life Cycle main branches are: Design & Engineering, Manufacturing and Use, Service & Recycling.

- Systems (Layer 3): After the data traffic has been sorted in the life cycle layer, the information is broken down further and distributed into different systems; once the data is placed into the appropriate system, it will begin to be used.

- Consumers (Layer 4): This layer is full of all the users or departments that will analyze the information, and find value in its contents.

- Usage (Layer 5): Finally, the information has reached its destination, and processed into reports for upper management viewing; these reports are used to determine various business, operations, engineering, maintenance and training functions involved in the manufacturing process.

However, there seems to be quite a few questions, concerns and obstacles when organizations begin their attempts to get to the level of “smart manufacturing”; some of the challenges are the following:

- *Diverse Data Sources:* Ecosystems in a manufacturing facility normally will have a high number of diverse protocols that operate on their own proprietary network for communication; integrating these networks will sometimes incur at large price tag, with extensive costs for engineering a middleware software to interpret the data. [8]

- *Scalable:* There can be an enormous number of data sources in a facility's ecosystem, so the ecosystem must have the ability to scale to a size that would incorporate the future growth plans that the company is aiming to achieve. Two areas that must be expandable for an automated data collection system to have the ability to grow is the equipment Data Logger (PLC memory) and System Server Capacity (Historian Storage/Data Integration Storage). The more information that an organization whatn to pull from its equipment, the more Data Logger (PLC memory) each piece of equipment needs to have at its disposal; as more information get process and transfer into the server to be analyzed, the more storage the overall data server needs to have in order to maintain a historical database. Again, the type of system installed in the facility will determine what type of Data Logging setup that will be required. A **Distributed System** will require a higher memory capacity Data Logger to be installed, as each piece of equipment acts as its own logging system and transfer its data into the ecosystem. On the other, a **Centralized System** one main data collection point and pulls information from each piece of equipment, minimizing the amount of storage that is required at every stand alone machine. [10]

- *Communication:* Communicating with the equipment is a major concern, in regards to **communication ability** and **speed**. There are two main ways that an automated data collection system can communicate with equipment: option one, is accomplished by communicating directly through the existing PLC controllers on the machine or option two is completed by installing a dedicated data collection device to each piece of equipment. Either of the two options are correct in nature per an organization's discretion, but if the equipment in the facility is already heavily, PLC controlled than option one is the more economically preferred choice. Connection speed can be an issue for any organization that is attempting to become a data driven manufacturing plant. If certain data sources are expected to provide real-time data streams of urgent information, than line lag is not an option in a "smart manufacturing" ecosystem. Thankfully, with the ubiquity of Ethernet in today's modern industry, old costly serial connections that slowed data transfer speed have almost been eliminated entirely; new PLC installations are coming with Ethernet modules built into the controllers. [9] [10]

- *Integration:* How data gets integrated into a form of understandable information, is an enormous question for companies that are new to data streaming in manufacturing; answering this question is extremely subjective to the type of system that is installed in the facility. Data collection systems that are being fashioned, to a new facility can be designed for information to flow at ease; the system components consisting of a data logger, database, report generator, and information viewer for real-time data streaming can be designed to match each other. However, installation of a data collection system into a facility that has evolved over a course of time can inherently have some obstacles that will need considered and thought through. As mentioned earlier, integrating all different breeds of data sources may require some type of middleware to interpret the data, and compute it into functioning information. Recap to option one and two for data communication that was spoke of above; depending on the make of PLC that the facility is using across the manufacturing floor, this can also affect data integration into usable information. Some PLCs can export directly to an Excel document for sorting and viewing, while others must be ran through a middleware software to be intergraded and sorted before it is sent to its appropriate system. [7]

A diverse ecosystem filled with multiple levels of information can foster a larger pool of knowledge across any organization, and create department specializations and potentially accelerate learning just by the adoption of this SM technology in the ecosystem. Taking all this digitized information and creating something useful out of it is the main goal of having a SM facility; being able to make decision that drastically affect the organization by applying the data that you have obtained. Data such as finished inventory part counts, machine statuses including run, idle and down time, alerts and error codes for equipment, operator login for accountability, and list continues to go on and on. [8]

Industry analysts have made the case that the biggest returns from smart manufacturing are found when a company's manufacturing leaders, moved beyond cost optimization in operations and invested in technology platforms with capabilities to contribute and build to an ecosystem enabling digital data transfer [8][10]. We are at an inflection point in manufacturing technology, where adopting new digital infrastructure and platforms are catalysts for the fourth industrial revolution to continue to grow. Only if an organization's ecosystem can evolve to support an infrastructure for higher levels of digital connectivity, orchestration, and optimization in the manufacturing value chain can a company truly obtain the status of being a "Smart Manufacturing" organization. [4][12]

Purpose

The purpose of the project research is to obtain the knowledge and have the ability for successfully launching an automatic data collection system at Futaba Indiana of American (FIA). The process will include the following phases or steps in order for the project to be successful: Planning and Cost, Implementation of upgrades to current outdated PLCs, creation of a Production Information Control Panel (PICP), PLC & GOT Programming for a customized system, Sonitrol Key Phob Interfacing, and communication testing between Legacy, Mid-ware software and the PICP. Upon finishing a successful pilot launch in a designated area and completing each of the previous steps, this system will provide accurate data of finished goods produced at the FIA manufacturing facility. The process will be documented throughout its conception and implementation phases; with the intent to be reproduced by all additional departments at FIA and other Futaba manufacturing facilities around North America.

Definitions

Andon – This manufacturing term generally refers to any type of system designed to notify management, maintenance, or other required department of a quality or process problem. The Andon in FIA's situation will be activated automatically by a button or automatically by the production equipment itself.

Automatic identification and data capture (AIDC) – This is term is somewhat generic in its nature, but it describes any type of technological development that allow an organization to automatically collect data and information from the manufacturing facility.

Human-Machine Interface (HMI/GOT) – These interface modules make it possible for a person to interact with a pre-programmed controller by monitoring process activities and even making changes to the process.

Legacy – This is an inventory management software used at Futaba North America (FNA) and all of our North American production facilities, where the software's main function is for tracking inventory levels at each facility. Futaba uses inventory management software to reduce the risk of excessive product production and it is a tool for organizing inventory data and generating reports.

Local Area Network (LAN) – This is an internal communication network that has the capacity to connect multiple devices; it also has the means and ability to allow information or data exchange across these same devices.

KDDI – Established in 1989 as a telecommunications business supporting Japanese multinationals, KDDI is the company that originally created the Legacy software that controls FIA's inventory records, and they are currently working on a middle software "Mid-ware" to talk between the PLC "Cloud" and Legacy software.

Overall Equipment Availability (OEA) – This measure is defined as the percentage of actual time that a piece of equipment or asset has operated compared to how long it was scheduled to operate.

Overall Equipment Efficiency (OEE) – This is the measure of equipment or process effectiveness based on actual availability, performance, and quality of the product or output.

Programmable Logic Controllers (PLC) – PLCs act as the central intelligence for many types of equipment. PLCs receive information through various types of sensors and inputs, and also control field devices with programmed outputs; they also can be used in AIDC applications where data is needed to be collected automatically. They operate using a programming language called Ladder Diagrams (LD) and are proprietary per the manufacturer.

Proximity - A proximity card, fob or (PROX) is a device that allows a contactless read without inserting anything into a reading device. The proximity cards or fobs are part of a newer contactless technologies. Holding this device near an electronic reader for just a moment enables the reader to accept the identification of an encoded number. The reader usually produces a beep or other sound to indicate the card has been read.

RS-232 Communication – This type of communication method is primarily found, in applications where low cost is more important than performance; one benefit to RS-232 is that it provides a guaranteed speed where Ethernet’s best effort speed is depending on the current network traffic. RS-232 has almost completely disappeared outside of industrial and certain other specialized applications.

Smart Manufacturing (SM) - Smart manufacturing is a reference to technology driven approaches, which utilize Internet or network connected machinery in order to monitor the production process. SM’s main goal is to determine what opportunities for efficiently automating operations and use the collected data to analyze and improve the manufacturing performance.

Sonitrol – This organization designs modular and scalable facility access solutions to fit the unique needs of each industry and organization. Sonitrol's access control system can track and restrict individuals by limiting who goes where and when throughout the building.

Supervisory Control And Data Acquisition (SCADA) – This represents a system consisting of purchased or custom software and hardware that enables an organization to have complete control over their processes. It allows the company to monitor and collect real-time data from their company's equipment locally or remotely by VPN access.

Assumptions

After the completion and successful launch of the automatic data collection system, I assume that FIA will see the following deliverables:

1. FIA Engineering team will have connection access capabilities to all final process welding equipment PLCs over internal network.
2. Complete Automatic Data Collection of all finished goods produced from final process welding production cells
3. Complete Total Time Management of all final process welding production cells connected to the system; Total Time Management includes:
    - Operation Run Time, Downtime and Idle Time
    - Fault Reset Records of all Individuals with authority access
    - Login records for Operators running equipment
4. Overhead Status Boards for Andon system management

Delimitations

The overall data collection project in our opinion should be relatively straight forward, as much of the PLC programming changes, PLC hardware replacement in the equipment control panels, and creation of the Production Information Control Panel (PICP) is programming and physical parts replacement. However, due to the timing of this research paper the mid-ware software, will not be completed by KDDI and will not be able to convert the data from a PLC language to a usable Excel interface for viewing the data. Although the mid-ware software will not be complete by KDDI, the main purpose of the research paper is examination of the creation and implementation of an automatic data collection in a manufacturing environment. If the conception of a system that automatically transfers data from floor level equipment (Layer 1) to valuable accurate information (Layer 5) works without flaw and as planned, the project has been a success.

Methodology

The idea for the automatic data collection system started at the end of 2018 at our sister facility FIO (Futaba Industrial of Ontario), located in Canada. We found out that they had started this new process when we called around to all of our branches, asking if anyone else was having any issues with inaccurate data collection. Former FIA President Hiroharu Murahashi, requested Senior IT Manager: Kimiko Kahre and Engineering Manager: myself to visit FIO; our task was to investigate what FIO had implemented to see if we could adapt it to our current system. FIO had successfully integrated their IT and production systems to the point of networking their manufacturing equipment into the server and sending live data every few minutes. After this investigation, FIA Engineering and Production Control conducted a two month accuracy study in the IPR (Instrument Panel Reinforcement) department; with the propose of evaluating the manual production sheet process that team members turn in at the end of each shift, against the actual inventory counted by PC analyst each morning (Figures 1-8). The study was initiated due to the fact that FIA inventory levels were constantly off target, showing every finished good part number being less than reported with the exception of one (Figure 9). The IPR production division was the easiest department in the plant to conduct this type of study, mainly because it only has 13 finished good main welding cells to track. This department was also the pilot area where Engineering implemented the first phase of the auto data collection system, and evaluated the progress and documented any issues that came about.

FIA not only struggles with an inventory accuracy issues throughout the entire plant, but also deals with machine fault reset accountability and total time management control. The conceptualized system will easily handle sending live stream data to the Legacy system (Figure 11), thus eliminating the need for team members to fill out production sheets (Figure 17). The proposed system will also track who is running the welding cell for “Out-Flow Accountability”, track what team member clears any fault logged by the welding cell during operation, and will account for all time associated with any given welding cell connected to the LAN. There is an understanding from the management group, that there will be multiple phases and steps in the creation and implementation of this data collection system for the entire plant. The overall process will take a large amount of time to see its completion, and as stated above the many phases or steps will be crucial for the success of the project.

The FIA Engineering and IT departments feel that along with the planning of the implementation of this project, we will also need to perform an evaluation on our current IT system; an evaluation of the server capacity is to determine if it is even capable of handling the amount of data that we desire to throw at it. Once we have concluded this server evaluation period, we hope the result will be that our current server is able to handle this larger amount of data; however, if this is not the case than FIA would need to upgrade our current IT server. We will also need to evaluate our current manufacturing equipment to decide if it has the capability to send data over an LAN connection. Engineering is going to focus our equipment evaluation on the IPR production division as the prototype area; again, this is mainly due to the fact of the department's size and this area will be presumably the easiest area to implement our plan while maintaining our timeline. Engineering will plan to upgrade any welding cells that are not capable of communication over Ethernet, meaning that these welding cells have antiquated PLC hardware (A-Series Mitsubishi CPUs); also upgrading any GOT (Graphic Operation Terminal) screen that is equipped with an outdated RS-232 Series communication port, and upgrade it to an Ethernet communication. Engineering's plan is to begin with the quoting process, in order to obtain accurate cost allocation for the project, and will then start putting together the implementation timing for each of the events.

Upgrade installations to the current outdated equipment's PLCs, will be conducted by FIA's Production Engineering (PE) team. PE's plan is to start by working on any outdated equipment in the IPR Production department; PE will need to schedule any conversions of A-series PLC controllers to Q-series PLC controllers. PE will also work with the IT Department to decide the locations of new network switches (hubs) and the Production Information Control Panel (PICP), or the "PLC Cloud" as PE will call it (Figure 10,12). The plan is that the "Cloud" will consist of a Q-series PLC and its own Ethernet communication switch module that will connect to all 13 Laser welding cells via their own upgraded Ethernet modules. PE will request the help of FIA's maintenance team to run all cable during the night shift production, in order to have less of an impact on day shift production.

The Engineering team's plan is to approach the programming portion of the project with caution; programming all of the IPR laser cells to send the correct information and along with creating a Production Information Control Panel (PICP) program for a customized system will bring some challenges. Using some of the new conversion software available from Mitsubishi, PE team will convert the programs from the A-series PLCs over to the new Q-series PLCs with ease hopefully. After an evaluation period of the updated hardware to the current production programs and confirmation of the welding cell change point, PE will then locate the proper input signals in the Ladder Logic for the "weld complete" status. At this point, the PE team should be able to transition into developing a new program to capture the desired data, and move it from the IPR Laser PLCs into the "Cloud".

This program will function by moving completed parts data, fault codes, and run time data into individual memory files in each welding cell; it will then send the data over Ethernet to the "Cloud", addressed to a very specific array of memory files arranged for each of the 13 welding cells. Every time a welding cell produces a finished good, issues a fault for an unwanted action, a team member logs in/out, or time stamps an action of operation in the welding cell, the PLC program will record the data, transfer it into a data registry and send it to the "Cloud" when instructed to do so. The orientation of the file addressing, data files, "MOVE" functions and arrhythmic instructions will be the main operations of the data collection program (Figures 14-16). PE will also create new GOT programs to accommodate the operator's interface with the PLC; this will allow the operator, to select the correct path to log data in the cloud for the equipment down time (DT) tracking (Figure 13). The plan is for the production operators logged into the welding cell to be accountable for the downtime that their equipment occurs.

Engineering has another intention for the overall project; our plan is to interface FIA's employee badges into the programming of the PLC. The plan is that this will allow the system to acknowledge and record who the team member is, that logged into the welding cell as the operator. The ability for the PLC to electronically acknowledge what team member badges into the cell, will be a major part of the auto data collection project. This function will also account for the total number of operators for each cell, team member fault reset tracking, and operator accountability.

The request for Engineering to program fault-reset tracking into the system is due to the fact that there is currently no way for management to know who resets faults on any given weld cell, without reading them from a computer with Mitsubishi software. There are many PROX badge readers available on the market that can interface with a PLC; however, with the knowledge our Engineering team has on the interworking capabilities of Mitsubishi PLCs, PE believes that the issue will be finding a badge reading system that will work with the Mitsubishi PLC. Another obstacle will be also finding a system that interfaces with our current HR employee database. This is a significant concern because at this moment, FIA's PE department does not want to take on the responsibility of maintaining another badge reader database for operator identification.

FIA currently uses a proximity, access restriction software made by Sonitrol for its building entry system, and human resources updates this entry restriction database every time they hire or terminated an individual. Engineering is hoping to find a way to interface FIA's current PROX badge system, into our PLC logic and use the already maintained database to pull from. This would allow FIA to place Sonitrol controllers systematically around the building on columns; then our plan is to run LAN connections from IT hubs to the controllers, and then from the controllers to the equipment PLC. The fore mentioned program will then be utilize to record the individual, team member data who is logged into any welding cell and performing any task on that cell.

The final step in our plan is at specific times through each shift the "Cloud" PLC will send the collected data back to the IT server to be saved, and converted into a viewable document such as an Excel format for usable information. This necessary conversion is unfortunately required because Mitsubishi PLCs cannot export data files to Excel or any viewable format other than LD language and require proprietary software for viewing. Futaba Japan and Futaba North America (FNA) are exploring the possibilities of drafting a contract with KDDI out of Chicago, Illinois, to create a middle software "Mid-ware" to talk between the PLC "Cloud" and Legacy. KDDI is the same company that originally constructed the Legacy software that controls our inventory management records. Once corporate has come to a decision, the software can be completed and uploaded into our system; FIA could then possibly have the ability to export finished goods data from the PLC "Cloud" into Legacy, and therefore be able to have accurate information effortlessly as a smart manufacturing company should.

Time Action Plan

Evaluation, implementation and confirmation for the phase one pilot area of IPR, is determined to consist of just over one company fiscal year. The initial manufacturing floor investigation for the project again, was conducting a two-month inventory audit for documented inaccuracies of the current IPR finished goods daily inventory numbers, evaluating the current level of existing equipment for network capabilities, and understanding the volume of data transfer that must occur for IT server capacities.

The elongated timeline for phase one of this project, is due primarily to the product line production schedule; Engineering is unable to access the welding cells for upgrades any other time than on company shutdowns, which occur only twice per calendar year in the months of July and December. A review date of current project status will be set for 14 months after project initiation, to return to FIO in Stratford, ON and conduct a progress meeting with FNA and FIO representatives.

Results

FIA visited its sister company in Canada, back in February of 2019 to investigate what FIO had implemented on their data collection system; attendees were the former FIA President Hiroharu Murahashi, Senior IT Manager: Kimiko Kahre and Engineering/PPG Manager: myself. The following information pertains to our initial deliverables and their outcomes after 13 months of development, implementation and installation. At current standing, FIA has upgraded, implemented and installed the following items in the IPR Production area and throughout the plant:

- Seven of the IPR welding cells needed their obsolete A-series PLCs upgraded to Q-series PLCs; this conversion was completed earlier than scheduled, due to finding available time on weekends when no production was occurring and due to the reduction of production volumes by Toyota. The PE team worked with the IPR Production division, to find weekends that we could take the welding cells from Friday to Sunday and complete the PLC conversions. (Figure 18)
- Five of the required IPR welding cells that needed their GOTs upgraded from serial communication to Ethernet communication has been finished; this conversion was completed earlier than scheduled, due to a reduction of production

volumes by Toyota. Engineering again worked with the IPR Production division to find weekends, that we could take the welding cells from Friday to Sunday and complete the GOT upgrades. (Figure 18)

- Two additional 40-port network switchgears (hub numbers 3 & 4), were mounted on columns on the East end of the FIA facility (Figure 12). Maintenance has not only completed the main network lines back to the IT server room for each of these hubs, but they have also completed the main Ethernet lines to all 13 laser welding cells in the IPR department going to hub #3.
- After the PLC conversions were completed, PE updated all (13) of the IPR laser welding cells with the newly created data collection program. Testing for proper information communication has been completed, with all welding cells are functioning correctly and moving data back to the Production Information Control Panel (PICP); the outcome of this portion is exactly how the Engineering team predicted it would be. The risk factor for this portion of the project was somewhat reduced, due to the fact that our engineering team is well verse in Mitsubishi programming and very much understands its capabilities and limitations. All the data flows from the welding cell PLC to the PICP "Cloud", and waiting to send it to the server "mid-ware" software once it is completed by KDDI.
- With the IPR welding cells now connected to the network, the Engineering team has the capability to access each of these PLCs over the network; this allows our team greater flexibility to connect, monitor and alter programs when required.
- Complete total time management of all welding cells connected to the system is operating correctly. Fault codes and their duration, operation "runtime",

downtime, and idle time data are being recorded in the individual welding cell's PLC. Again, all the data flows from the individual welding cell PLC to the PICP "Cloud", and as stated above now currently waiting to send it to the server "mid-ware" software once it is completed by KDDI.

- Overhead status boards and implementation of an Andon system for FIA management was completed on schedule. FIA has currently hung four status boards in the IPR department and linked the PLCs connected to the network to the intercom system. The PLC programming watches for machine efficiency, downtime, idle time and faults; whenever the OEE dips below a given amount or the equipment exceeds a preset time associated for downtime, idle time and machine faults, the status board visually changes per the associated cell and alerts over the intercom system that there is an issue.
- Unfortunately, at this time KDDI has yet to complete the mid-ware software and we have not yet been able to test communication back to the server. Without this mid-ware interface between the server and the Mitsubishi, we cannot get data from the PICP and convert it to a usable document for production managers and senior management. PE is still having to provide downtime (DT) data and fault records to any department that request this information.
- Tracking of all team member's login records for operators running equipment and fault reset records of all team members operating the equipment are currently, not recorded. The programming in each welding cell PLC supports the data transfer through designated data files, but currently we have not developed the method to correct the issues mentioned in the limitations section of this paper. Our Canadian

facility FIO, is currently still using the GOT key pad and giving operators an individual entry code to log who operates the welding cell. The issue with this practice is that it's proven, that team members will use other team members logins to avoid a change to be associate with an outflow of a finished good. This portion of the project is still a work in progress and still in discussion as to what the final direction will be.

- Additionally, FIA has had to abandon our efforts to use the Sonitrol system as the hardware and software program. Engineering desired to use this system to record the individual team members, who were logged into any welding cell and performing tasks on that cell. However, due to the limitations of the hardware controllers we are not able to accomplish this. PE and IT are now working with KDDI again, to alter the mid-ware software; we hope to develop a solution to this issue by expanding the program and using key codes on the GOT screen.

Limitations

At this point in the duration of the data collection project, there has been only one major obstacle, setback or limitation depending the viewpoint of the matter. The Sonitrol access control system is designed to accept an input from a proximity reader, and determine if that card/fob has access rights based on allowing only certain cards/fob to be permitted entry. Each controller has to ability to hold its own data registry of authorized individuals; when an authorize individual scans their card/fob over the proximity reader, the controller closes an output relay and sends a 24V signal. While trying to utilize the Sonitrol controller in our data collection system, we have encountered two main issues.

The first issue when trying to utilize this controller as an input to the PLC for team member authorization is that it only provides a single digital output from the controller to the PLC and this constitutes a variety of problems:

- One of the goals of this project were to eliminate reset keys from the production floor, and capture what team members were resetting fault codes on the equipment. A single output to the PLC restricts the programming to only being able to accept a single input from the controller, in order for the PLC to get confirmation of an authorized team member. This means that FIA will have to leave the reset keys on the floor for an additional level of authorization, above the baseline operator.

The second issue is that there can be up to a maximum of four operators on an automated welding cell line; FIA wants to account for the total number of operators running a welding cell, in order to calculate total efficiency of each welding cell line.

- Another goal of the project is for the PLCs to calculate the total efficiency of the welding line, once it knows how many operators have logged in to run the cells and based on the total output of the cell at the end of each rotation. Each operator has a login station at each GOT, on the assembly line. However, the Sonitrol software cannot distinguish if the same operator logged into two different stations; this mean that if production manning is low on any certain line, the same operator could log into multiple stations and the final efficiency numbers would be off.

Conclusion

The purpose again when seeking out new technology, developing that current technology and actively using that technology, is whether it makes our lives and jobs better and more efficient. My final overview and opinion of this project is one that mostly met my expectations; I make this statement with the attempt to be as fair as possible, while also being slightly bias when saying that I believe we completed the majority the tasks that we originally set out to accomplish. We understand now, on a much more detailed and higher level, some of the obstacles that we need to overcome in the near future to complete the remaining open tasks and finalize the data collection project at FIA.

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Appendix

Figure 1

Model	Part Number	Calculated	Actual	12/2/18	Percentage
010B	55330-06460	1826	1840	14	0.76%
370B	55330-07080	260	256	-4	-1.56%
841A	55330-08040	220	234	14	5.98%
200L	55330-0C080	55	55	0	0.00%
241B	55330-06560	207	192	-15	-7.81%
150B	55330-02D00	1149	1080	-69	-6.39%
150B	55330-02A30	60	60	0	0.00%
550B	55330-0E150	354	360	6	1.67%
550B	55330-0E130	24	24	0	0.00%

Model	Part Number	Calculated	Actual	12/3/18	Percentage
010B	55330-06460	1415	1424	9	0.63%
370B	55330-07080	245	208	-37	-17.79%
841A	55330-08040	135	99	-36	-36.36%
200L	55330-0C080	33	33	0	0.00%
241B	55330-06560	141	144	3	2.08%
150B	55330-02D00	1083	1188	105	8.84%
150B	55330-02A30	48	48	0	0.00%
550B	55330-0E150	33	36	3	8.33%
550B	55330-0E130	150	180	30	16.67%

Model	Part Number	Calculated	Actual	12/4/18	Percentage
010B	55330-06460	1202	1136	-66	-5.81%
370B	55330-07080	211	240	29	12.08%
841A	55330-08040	90	99	9	9.09%
200L	55330-0C080	11	11	0	0.00%
241B	55330-06560	100	96	-4	-4.17%
150B	55330-02D00	1041	1020	-21	-2.06%
150B	55330-02A30	36	36	0	0.00%
550B	55330-0E150	0	0	0	#DIV/0!
550B	55330-0E130	108	72	-36	-50.00%

Model	Part Number	Calculated	Actual	12/5/18	Percentage
010B	55330-06460	1045	992	-53	-5.34%
370B	55330-07080	257	256	-1	-0.39%
841A	55330-08040	27	27	0	0.00%
200L	55330-0C080	46	55	9	16.36%
241B	55330-06560	40	36	-4	-11.11%
150B	55330-02D00	1021	1020	-1	-0.10%
150B	55330-02A30	24	24	0	0.00%
550B	55330-0E150	0	0	0	#DIV/0!
550B	55330-0E130	28	60	32	53.33%

Model	Part Number	Calculated	Actual	12/6/18	Percentage
010B	55330-06460	784	736	-48	-6.52%
370B	55330-07080	211	208	-3	-1.44%
841A	55330-08040	120	117	-3	-2.56%
200L	55330-0C080	44	33	-11	-33.33%
241B	55330-06560	10	12	2	16.67%
150B	55330-02D00	1046	1032	-14	-1.36%
150B	55330-02A30	12	12	0	0.00%
550B	55330-0E150	12	9	-3	-33.33%
550B	55330-0E130	242	240	-2	-0.83%

Model	Part Number	Calculated	Actual	12/7/18	Percentage
010B	55330-06460	479	496	17	3.43%
370B	55330-07080	160	160	0	0.00%
841A	55330-08040	117	117	0	0.00%
200L	55330-0C080	22	11	-11	-100.00%
241B	55330-06560	0	1	1	100.00%
150B	55330-02D00	501	480	-21	-4.38%
150B	55330-02A30	0	0	0	#DIV/0!
550B	55330-0E150	113	72	-41	-56.94%
550B	55330-0E130	11	12	1	8.33%

Model	Part Number	Calculated	Actual		Percentage
010B	55330-06460			0	#DIV/0!
370B	55330-07080			0	#DIV/0!
841A	55330-08040			0	#DIV/0!
200L	55330-0C080			0	#DIV/0!
241B	55330-06560			0	#DIV/0!
150B	55330-02D00			0	#DIV/0!
150B	55330-02A30			0	#DIV/0!
550B	55330-0E150			0	#DIV/0!
550B	55330-0E130			0	#DIV/0!

Week 1

Figure 2

Model	Part Number	Calculated	Actual	12/9/18	Percentage
010B	55330-06460	2110	2128	18	0.85%
370B	55330-07080	229	192	-37	-19.27%
841A	55330-08040	242	261	19	7.28%
200L	55330-0C080	39	33	-6	-18.18%
241B	55330-06560	182	180	-2	-1.11%
150B	55330-02D00	1108	1056	-52	-4.92%
150B	55330-02A30	25	24	-1	-4.17%
550B	55330-0E150	117	108	-9	-8.33%
550B	55330-0E130	358	360	2	0.56%

Model	Part Number	Calculated	Actual	12/10/18	Percentage
010B	55330-06460	1645	1664	19	1.14%
370B	55330-07080	116	144	28	19.44%
841A	55330-08040	367	333	-34	-10.21%
200L	55330-0C080	11	11	0	0.00%
241B	55330-06560	117	108	-9	-8.33%
150B	55330-02D00	939	876	-63	-7.19%
150B	55330-02A30	12	12	0	0.00%
550B	55330-0E150	60	60	0	0.00%
550B	55330-0E130	235	204	-31	-15.20%

Model	Part Number	Calculated	Actual	12/11/18	Percentage
010B	55330-06460	1361	1328	-33	-2.48%
370B	55330-07080	144	144	0	0.00%
841A	55330-08040	333	333	0	0.00%
200L	55330-0C080	66	66	0	0.00%
241B	55330-06560	65	60	-5	-8.33%
150B	55330-02D00	566	552	-14	-2.54%
150B	55330-02A30	118	108	-10	-9.26%
550B	55330-0E150	104	108	4	3.70%
550B	55330-0E130	181	156	-25	-16.03%

Model	Part Number	Calculated	Actual	12/12/18	Percentage
010B	55330-06460	618	784	166	21.17%
370B	55330-07080	158	160	2	1.25%
841A	55330-08040	333	333	0	0.00%
200L	55330-0C080	44	44	0	0.00%
241B	55330-06560	51	48	-3	-6.25%
150B	55330-02D00	481	468	-13	-2.78%
150B	55330-02A30	96	96	0	0.00%
550B	55330-0E150	78	72	-6	-8.33%
550B	55330-0E130	160	120	-40	-33.33%

Model	Part Number	Calculated	Actual	12/13/18	Percentage
010B	55330-06460	397	368	-29	-7.88%
370B	55330-07080	122	112	-10	-8.93%
841A	55330-08040	234	234	0	0.00%
200L	55330-0C080	89	88	-1	-1.14%
241B	55330-06560	38	36	-2	-5.56%
150B	55330-02D00	380	372	-8	-2.15%
150B	55330-02A30	96	96	0	0.00%
550B	55330-0E150	24	24	0	0.00%
550B	55330-0E130	104	84	-20	-23.81%

Model	Part Number	Calculated	Actual	12/14/18	Percentage
010B	55330-06460			0	#DIV/0!
370B	55330-07080			0	#DIV/0!
841A	55330-08040			0	#DIV/0!
200L	55330-0C080			0	#DIV/0!
241B	55330-06560			0	#DIV/0!
150B	55330-02D00			0	#DIV/0!
150B	55330-02A30			0	#DIV/0!
550B	55330-0E150			0	#DIV/0!
550B	55330-0E130			0	#DIV/0!

Model	Part Number	Calculated	Actual		Percentage
010B	55330-06460			0	#DIV/0!
370B	55330-07080			0	#DIV/0!
841A	55330-08040			0	#DIV/0!
200L	55330-0C080			0	#DIV/0!
241B	55330-06560			0	#DIV/0!
150B	55330-02D00			0	#DIV/0!
150B	55330-02A30			0	#DIV/0!
550B	55330-0E150			0	#DIV/0!
550B	55330-0E130			0	#DIV/0!

Week 2

Figure 3

Model	Part Number	Calculated	Actual	12/16/18	Percentage
010B	55330-06460	2086	2080	-6	-0.29%
370B	55330-07080	128	133	5	3.76%
841A	55330-08040	214	216	2	0.93%
200L	55330-0C080	66	66	0	0.00%
241B	55330-06560	206	204	-2	-0.98%
150B	55330-02D00	965	948	-17	-1.79%
150B	55330-02A30	84	84	0	0.00%
550B	55330-0E150	693	636	-57	-8.96%
550B	55330-0E130	180	180	0	0.00%

Model	Part Number	Calculated	Actual	12/17/18	Percentage
010B	55330-06460	1910	1856	-54	-2.91%
370B	55330-07080	130	144	14	9.72%
841A	55330-08040	144	144	0	0.00%
200L	55330-0C080	52	44	-8	-18.18%
241B	55330-06560	100	96	-4	-4.17%
150B	55330-02D00	927	924	-3	-0.32%
150B	55330-02A30	72	72	0	0.00%
550B	55330-0E150	522	516	-6	-1.16%
550B	55330-0E130	135	132	-3	-2.27%

Model	Part Number	Calculated	Actual	12/18/18	Percentage
010B	55330-06460	1962	1952	-10	-0.51%
370B	55330-07080	132	112	-20	-17.86%
841A	55330-08040	150	144	-6	-4.17%
200L	55330-0C080	0	22	22	100.00%
241B	55330-06560	1	0	-1	#DIV/0!
150B	55330-02D00	806	792	-14	-1.77%
150B	55330-02A30	60	60	0	0.00%
550B	55330-0E150	72	72	0	0.00%
550B	55330-0E130	616	540	-76	-14.07%

Model	Part Number	Calculated	Actual	12/19/18	Percentage
010B	55330-06460	1818	1776	-42	-2.36%
370B	55330-07080	97	96	-1	-1.04%
841A	55330-08040	165	162	-3	-1.85%
200L	55330-0C080	26	33	7	21.21%
241B	55330-06560	15	12	-3	-25.00%
150B	55330-02D00	685	684	-1	-0.15%
150B	55330-02A30	60	60	0	0.00%
550B	55330-0E150	74	72	-2	-2.78%
550B	55330-0E130	480	456	-24	-5.26%

Model	Part Number	Calculated	Actual	12/20/18	Percentage
010B	55330-06460	1711	1792	81	4.52%
370B	55330-07080	132	128	-4	-3.13%
841A	55330-08040	171	171	0	0.00%
200L	55330-0C080	111	110	-1	-0.91%
241B	55330-06560	47	48	1	2.08%
150B	55330-02D00	600	588	-12	-2.04%
150B	55330-02A30	48	48	0	0.00%
550B	55330-0E150	70	48	-22	-45.83%
550B	55330-0E130	423	408	-15	-3.68%

Model	Part Number	Calculated	Actual	12/21/18	Percentage
010B	55330-06460			0	#DIV/0!
370B	55330-07080			0	#DIV/0!
841A	55330-08040			0	#DIV/0!
200L	55330-0C080			0	#DIV/0!
241B	55330-06560			0	#DIV/0!
150B	55330-02D00			0	#DIV/0!
150B	55330-02A30			0	#DIV/0!
550B	55330-0E150			0	#DIV/0!
550B	55330-0E130			0	#DIV/0!

Model	Part Number	Calculated	Actual	12/22/18	Percentage
010B	55330-06460			0	#DIV/0!
370B	55330-07080			0	#DIV/0!
841A	55330-08040			0	#DIV/0!
200L	55330-0C080			0	#DIV/0!
241B	55330-06560			0	#DIV/0!
150B	55330-02D00			0	#DIV/0!
150B	55330-02A30			0	#DIV/0!
550B	55330-0E150			0	#DIV/0!
550B	55330-0E130			0	#DIV/0!

Week 3

Figure 4

Model	Part Number	Calculated	Actual	12/30/18	Percentage
010B	55330-06460			0	#DIV/0!
370B	55330-07080			0	#DIV/0!
841A	55330-08040			0	#DIV/0!
200L	55330-0C080			0	#DIV/0!
241B	55330-06560			0	#DIV/0!
150B	55330-02D00			0	#DIV/0!
150B	55330-02A30			0	#DIV/0!
550B	55330-0E150			0	#DIV/0!
550B	55330-0E130			0	#DIV/0!

Model	Part Number	Calculated	Actual	12/31/18	Percentage
010B	55330-06460			0	#DIV/0!
370B	55330-07080			0	#DIV/0!
841A	55330-08040			0	#DIV/0!
200L	55330-0C080			0	#DIV/0!
241B	55330-06560			0	#DIV/0!
150B	55330-02D00			0	#DIV/0!
150B	55330-02A30			0	#DIV/0!
550B	55330-0E150			0	#DIV/0!
550B	55330-0E130			0	#DIV/0!

Model	Part Number	Calculated	Actual	1/1/19	Percentage
010B	55330-06460			0	#DIV/0!
370B	55330-07080			0	#DIV/0!
841A	55330-08040			0	#DIV/0!
200L	55330-0C080			0	#DIV/0!
241B	55330-06560			0	#DIV/0!
150B	55330-02D00			0	#DIV/0!
150B	55330-02A30			0	#DIV/0!
550B	55330-0E150			0	#DIV/0!
550B	55330-0E130			0	#DIV/0!

Model	Part Number	Calculated	Actual	1/2/19	Percentage
010B	55330-06460	1688	1664	-24	-1.44%
370B	55330-07080	241	256	15	5.86%
841A	55330-08040	220	189	-31	-16.40%
200L	55330-0C080	77	77	0	0.00%
241B	55330-06560	208	204	-4	-1.96%
150B	55330-02D00	794	840	46	5.48%
150B	55330-02A30	36	36	0	0.00%
550B	55330-0E150	112	132	20	15.15%
550B	55330-0E130	432	408	-24	-5.88%

SHUTDOWN

Model	Part Number	Calculated	Actual	1/3/19	Percentage
010B	55330-06460	1293	1264	-29	-2.29%
370B	55330-07080	266	272	6	2.21%
841A	55330-08040	172	198	26	13.13%
200L	55330-0C080	71	66	-5	-7.58%
241B	55330-06560	207	204	-3	-1.47%
150B	55330-02D00	730	708	-22	-3.11%
150B	55330-02A30	24	24	0	0.00%
550B	55330-0E150	84	60	-24	-40.00%
550B	55330-0E130	180	192	12	6.25%

Model	Part Number	Calculated	Actual		Percentage
010B	55330-06460			0	#DIV/0!
370B	55330-07080			0	#DIV/0!
841A	55330-08040			0	#DIV/0!
200L	55330-0C080			0	#DIV/0!
241B	55330-06560			0	#DIV/0!
150B	55330-02D00			0	#DIV/0!
150B	55330-02A30			0	#DIV/0!
550B	55330-0E150			0	#DIV/0!
550B	55330-0E130			0	#DIV/0!

Model	Part Number	Calculated	Actual		Percentage
010B	55330-06460			0	#DIV/0!
370B	55330-07080			0	#DIV/0!
841A	55330-08040			0	#DIV/0!
200L	55330-0C080			0	#DIV/0!
241B	55330-06560			0	#DIV/0!
150B	55330-02D00			0	#DIV/0!
150B	55330-02A30			0	#DIV/0!
550B	55330-0E150			0	#DIV/0!
550B	55330-0E130			0	#DIV/0!

Week 4

Figure 5

Model	Part Number	Calculated	Actual	1/6/19	Percentage
010B	55330-06460	1990	1968	-22	-1.12%
370B	55330-07080	259	256	-3	-1.17%
841A	55330-08040	265	270	5	1.85%
200L	55330-0C080	133	143	10	6.99%
241B	55330-06560	206	204	-2	-0.98%
150B	55330-02D00	907	888	-19	-2.14%
150B	55330-02A30	123	120	-3	-2.50%
550B	55330-0E150	198	192	-6	-3.13%
550B	55330-0E130	809	768	-41	-5.34%

Model	Part Number	Calculated	Actual	1/7/19	Percentage
010B	55330-06460	1642	1616	-26	-1.61%
370B	55330-07080	144	144	0	0.00%
841A	55330-08040	276	270	-6	-2.22%
200L	55330-0C080	121	121	0	0.00%
241B	55330-06560	185	180	-5	-2.78%
150B	55330-02D00	804	792	-12	-1.52%
150B	55330-02A30	108	108	0	0.00%
550B	55330-0E150	184	180	-4	-2.22%
550B	55330-0E130	677	672	-5	-0.74%

Model	Part Number	Calculated	Actual	1/8/19	Percentage
010B	55330-06460	1482	1440	-42	-2.92%
370B	55330-07080	165	160	-5	-3.13%
841A	55330-08040	189	180	-9	-5.00%
200L	55330-0C080	88	77	-11	-14.29%
241B	55330-06560	194	192	-2	-1.04%
150B	55330-02D00	627	600	-27	-4.50%
150B	55330-02A30	96	96	0	0.00%
550B	55330-0E150	185	204	19	9.31%
550B	55330-0E130	623	552	-71	-12.86%

Model	Part Number	Calculated	Actual	1/9/19	Percentage
010B	55330-06460	1169	1136	-33	-2.90%
370B	55330-07080	167	160	-7	-4.38%
841A	55330-08040	179	180	1	0.56%
200L	55330-0C080	55	55	0	0.00%
241B	55330-06560	206	204	-2	-0.98%
150B	55330-02D00	518	480	-38	-7.92%
150B	55330-02A30	84	84	0	0.00%
550B	55330-0E150	204	204	0	0.00%
550B	55330-0E130	455	432	-23	-5.32%

Model	Part Number	Calculated	Actual	1/10/19	Percentage
010B	55330-06460	978	960	-18	-1.88%
370B	55330-07080	189	192	3	1.56%
841A	55330-08040	183	180	-3	-1.67%
200L	55330-0C080	33	33	0	0.00%
241B	55330-06560	189	180	-9	-5.00%
150B	55330-02D00	396	366	-30	-8.20%
150B	55330-02A30	72	72	0	0.00%
550B	55330-0E150	208	204	-4	-1.96%
550B	55330-0E130	313	312	-1	-0.32%

Model	Part Number	Calculated	Actual	1/11/19	Percentage
010B	55330-06460	948	928	-20	-2.16%
370B	55330-07080	210	208	-2	-0.96%
841A	55330-08040	81	81	0	0.00%
200L	55330-0C080	114	109	-5	-4.59%
241B	55330-06560	151	156	5	3.21%
150B	55330-02D00	140	120	-20	-16.67%
150B	55330-02A30	60	60	0	0.00%
550B	55330-0E150	195	192	-3	-1.56%
550B	55330-0E130	212	192	-20	-10.42%

Model	Part Number	Calculated	Actual	1/12/19	Percentage
010B	55330-06460			0	#DIV/0!
370B	55330-07080			0	#DIV/0!
841A	55330-08040			0	#DIV/0!
200L	55330-0C080			0	#DIV/0!
241B	55330-06560			0	#DIV/0!
150B	55330-02D00			0	#DIV/0!
150B	55330-02A30			0	#DIV/0!
550B	55330-0E150			0	#DIV/0!
550B	55330-0E130			0	#DIV/0!

Week 5

Figure 6

Model	Part Number	Calculated	Actual	1/13/19	Percentage
010B	55330-06460	2067	2048	-19	-0.93%
370B	55330-07080	268	208	-60	-28.85%
841A	55330-08040	263	261	-2	-0.77%
200L	55330-0C080	131	132	1	0.76%
241B	55330-06560	156	156	0	0.00%
150B	55330-02D00	937	912	-25	-2.74%
150B	55330-02A30	60	60	0	0.00%
550B	55330-0E150	192	192	0	0.00%
550B	55330-0E130	879	888	9	1.01%

Model	Part Number	Calculated	Actual	1/14/19	Percentage
010B	55330-06460	1739	1648	-91	-5.52%
370B	55330-07080	228	224	-4	-1.79%
841A	55330-08040	153	153	0	0.00%
200L	55330-0C080	110	110	0	0.00%
241B	55330-06560	172	168	-4	-2.38%
150B	55330-02D00	964	936	-28	-2.99%
150B	55330-02A30	48	48	0	0.00%
550B	55330-0E150	186	180	-6	-3.33%
550B	55330-0E130	793	756	-37	-4.89%

Model	Part Number	Calculated	Actual	1/15/19	Percentage
010B	55330-06460	1308	1344	36	2.68%
370B	55330-07080	186	176	-10	-5.68%
841A	55330-08040	147	153	6	3.92%
200L	55330-0C080	77	77	0	0.00%
241B	55330-06560	183	180	-3	-1.67%
150B	55330-02D00	972	972	0	0.00%
150B	55330-02A30	36	36	0	0.00%
550B	55330-0E150	185	180	-5	-2.78%
550B	55330-0E130	556	492	-64	-13.01%

Model	Part Number	Calculated	Actual	1/16/19	Percentage
010B	55330-06460	1081	1072	-9	-0.84%
370B	55330-07080	191	192	1	0.52%
841A	55330-08040	154	153	-1	-0.65%
200L	55330-0C080	55	55	0	0.00%
241B	55330-06560	160	156	-4	-2.56%
150B	55330-02D00	828	816	-12	-1.47%
150B	55330-02A30	36	36	0	0.00%
550B	55330-0E150	174	168	-6	-3.57%
550B	55330-0E130	491	432	-59	-13.66%

Model	Part Number	Calculated	Actual	1/17/19	Percentage
010B	55330-06460	814	800	-14	-1.75%
370B	55330-07080	242	224	-18	-8.04%
841A	55330-08040	179	171	-8	-4.68%
200L	55330-0C080	33	33	0	0.00%
241B	55330-06560	173	168	-5	-2.98%
150B	55330-02D00	662	660	-2	-0.30%
150B	55330-02A30	24	24	0	0.00%
550B	55330-0E150	172	168	-4	-2.38%
550B	55330-0E130	507	432	-75	-17.36%

Model	Part Number	Calculated	Actual	1/18/19	Percentage
010B	55330-06460			0	#DIV/0!
370B	55330-07080			0	#DIV/0!
841A	55330-08040			0	#DIV/0!
200L	55330-0C080			0	#DIV/0!
241B	55330-06560			0	#DIV/0!
150B	55330-02D00			0	#DIV/0!
150B	55330-02A30			0	#DIV/0!
550B	55330-0E150			0	#DIV/0!
550B	55330-0E130			0	#DIV/0!

Model	Part Number	Calculated	Actual	1/19/19	Percentage
010B	55330-06460			0	#DIV/0!
370B	55330-07080			0	#DIV/0!
841A	55330-08040			0	#DIV/0!
200L	55330-0C080			0	#DIV/0!
241B	55330-06560			0	#DIV/0!
150B	55330-02D00			0	#DIV/0!
150B	55330-02A30			0	#DIV/0!
550B	55330-0E150			0	#DIV/0!
550B	55330-0E130			0	#DIV/0!

Week 6

Figure 7

Model	Part Number	Calculated	Actual	1/20/19	Percentage
010B	55330-06460	2187	2160	-27	-1.25%
370B	55330-07080	258	272	14	5.15%
841A	55330-08040	210	198	-12	-6.06%
200L	55330-0C080	68	66	-2	-3.03%
241B	55330-06560	163	156	-7	-4.49%
150B	55330-02D00	1058	1044	-14	-1.34%
150B	55330-02A30	111	108	-3	-2.78%
550B	55330-0E150	185	180	-5	-2.78%
550B	55330-0E130	759	816	57	6.99%

Model	Part Number	Calculated	Actual	1/21/19	Percentage
010B	55330-06460	1937	1888	-49	-2.60%
370B	55330-07080	217	208	-9	-4.33%
841A	55330-08040	65	63	-2	-3.17%
200L	55330-0C080	44	44	0	0.00%
241B	55330-06560	105	96	-9	-9.38%
150B	55330-02D00	763	744	-19	-2.55%
150B	55330-02A30	96	96	0	0.00%
550B	55330-0E150	168	168	0	0.00%
550B	55330-0E130	606	576	-30	-5.21%

Model	Part Number	Calculated	Actual	1/22/19	Percentage
010B	55330-06460	1342	1296	-46	-3.55%
370B	55330-07080	199	208	9	4.33%
841A	55330-08040	89	90	1	1.11%
200L	55330-0C080	11	11	0	0.00%
241B	55330-06560	78	72	-6	-8.33%
150B	55330-02D00	435	432	-3	-0.69%
150B	55330-02A30	84	84	0	0.00%
550B	55330-0E150	171	168	-3	-1.79%
550B	55330-0E130	434	408	-26	-6.37%

Model	Part Number	Calculated	Actual	1/23/19	Percentage
010B	55330-06460	968	976	8	0.82%
370B	55330-07080	240	224	-16	-7.14%
841A	55330-08040	96	90	-6	-6.67%
200L	55330-0C080	30	22	-8	-36.36%
241B	55330-06560	83	84	1	1.19%
150B	55330-02D00	359	348	-11	-3.16%
150B	55330-02A30	72	72	0	0.00%
550B	55330-0E150	170	168	-2	-1.19%
550B	55330-0E130	216	192	-24	-12.50%

Model	Part Number	Calculated	Actual	1/24/19	Percentage
010B	55330-06460	783	736	-47	-6.39%
370B	55330-07080	240	240	0	0.00%
841A	55330-08040	67	63	-4	-6.35%
200L	55330-0C080	34	33	-1	-3.03%
241B	55330-06560	88	84	-4	-4.76%
150B	55330-02D00	302	288	-14	-4.86%
150B	55330-02A30	60	60	0	0.00%
550B	55330-0E150	111	108	-3	-2.78%
550B	55330-0E130	144	144	0	0.00%

Model	Part Number	Calculated	Actual	1/25/19	Percentage
010B	55330-06460	573	512	-61	-11.91%
370B	55330-07080	160	160	0	0.00%
841A	55330-08040	60	54	-6	-11.11%
200L	55330-0C080	0	0	0	#DIV/0!
241B	55330-06560	53	48	-5	-10.42%
150B	55330-02D00	261	264	3	1.14%
150B	55330-02A30	60	60	0	0.00%
550B	55330-0E150	36	36	0	0.00%
550B	55330-0E130	200	192	-8	-4.17%

Model	Part Number	Calculated	Actual	1/26/19	Percentage
010B	55330-06460			0	#DIV/0!
370B	55330-07080			0	#DIV/0!
841A	55330-08040			0	#DIV/0!
200L	55330-0C080			0	#DIV/0!
241B	55330-06560			0	#DIV/0!
150B	55330-02D00			0	#DIV/0!
150B	55330-02A30			0	#DIV/0!
550B	55330-0E150			0	#DIV/0!
550B	55330-0E130			0	#DIV/0!

Week 7

Figure 8

Model	Part Number	Calculated	Actual	1/27/20	Percentage
010B	55330-06460	2080	20296	18216	89.75%
370B	55330-07080	201	176	-25	-14.20%
841A	55330-08040	263	279	16	5.73%
200L	55330-0C080	45	44	-1	-2.27%
241B	55330-06560	206	204	-2	-0.98%
150B	55330-02D00	958	960	2	0.21%
150B	55330-02A30	60	60	0	0.00%
550B	55330-0E150	196	192	-4	-2.08%
550B	55330-0E130	893	888	-5	-0.56%

Model	Part Number	Calculated	Actual	1/28/20	Percentage
010B	55330-06460	1743	1712	-31	-1.81%
370B	55330-07080	154	176	22	12.50%
841A	55330-08040	275	261	-14	-5.36%
200L	55330-0C080	22	22	0	0.00%
241B	55330-06560	207	204	-3	-1.47%
150B	55330-02D00	871	840	-31	-3.69%
150B	55330-02A30	110	108	-2	-1.85%
550B	55330-0E150	196	192	-4	-2.08%
550B	55330-0E130	601	564	-37	-6.56%

Model	Part Number	Calculated	Actual	1/29/20	Percentage
010B	55330-06460	1376	1344	-32	-2.38%
370B	55330-07080	250	256	6	2.34%
841A	55330-08040	224	225	1	0.44%
200L	55330-0C080	43	33	-10	-30.30%
241B	55330-06560	205	204	-1	-0.49%
150B	55330-02D00	859	840	-19	-2.26%
150B	55330-02A30	96	96	0	0.00%
550B	55330-0E150	193	192	-1	-0.52%
550B	55330-0E130	442	396	-46	-11.62%

Model	Part Number	Calculated	Actual	1/30/20	Percentage
010B	55330-06460	1151	1104	-47	-4.26%
370B	55330-07080	176	176	0	0.00%
841A	55330-08040	216	216	0	0.00%
200L	55330-0C080	61	66	5	7.58%
241B	55330-06560	148	144	-4	-2.78%
150B	55330-02D00	828	816	-12	-1.47%
150B	55330-02A30	84	84	0	0.00%
550B	55330-0E150	193	192	-1	-0.52%
550B	55330-0E130	386	468	82	17.52%

Model	Part Number	Calculated	Actual	1/31/20	Percentage
010B	55330-06460	771	752	-19	-2.53%
370B	55330-07080	217	208	-9	-4.33%
841A	55330-08040	192	189	-3	-1.59%
200L	55330-0C080	44	44	0	0.00%
241B	55330-06560	159	156	-3	-1.92%
150B	55330-02D00	620	612	-8	-1.31%
150B	55330-02A30	72	72	0	0.00%
550B	55330-0E150	196	192	-4	-2.08%
550B	55330-0E130	460	432	-28	-6.48%

Model	Part Number	Calculated	Actual	2/1/20	Percentage
010B	55330-06460			0	#DIV/0!
370B	55330-07080			0	#DIV/0!
841A	55330-08040			0	#DIV/0!
200L	55330-0C080			0	#DIV/0!
241B	55330-06560			0	#DIV/0!
150B	55330-02D00			0	#DIV/0!
150B	55330-02A30			0	#DIV/0!
550B	55330-0E150			0	#DIV/0!
550B	55330-0E130			0	#DIV/0!

Model	Part Number	Calculated	Actual	2/2/20	Percentage
010B	55330-06460			0	#DIV/0!
370B	55330-07080			0	#DIV/0!
841A	55330-08040			0	#DIV/0!
200L	55330-0C080			0	#DIV/0!
241B	55330-06560			0	#DIV/0!
150B	55330-02D00			0	#DIV/0!
150B	55330-02A30			0	#DIV/0!
550B	55330-0E150			0	#DIV/0!
550B	55330-0E130			0	#DIV/0!

Week 8

Figure 9

Model	Part Number	Total Average
010B	55330-06460	0.81%
370B	55330-07080	-1.48%
841A	55330-08040	-1.78%
200L	55330-0C080	-2.58%
241B	55330-06560	-1.01%
150B	55330-02D00	-2.10%
150B	55330-02A30	-0.49%
550B	55330-0E150	-5.67%
550B	55330-0E130	-4.79%

Figure 10

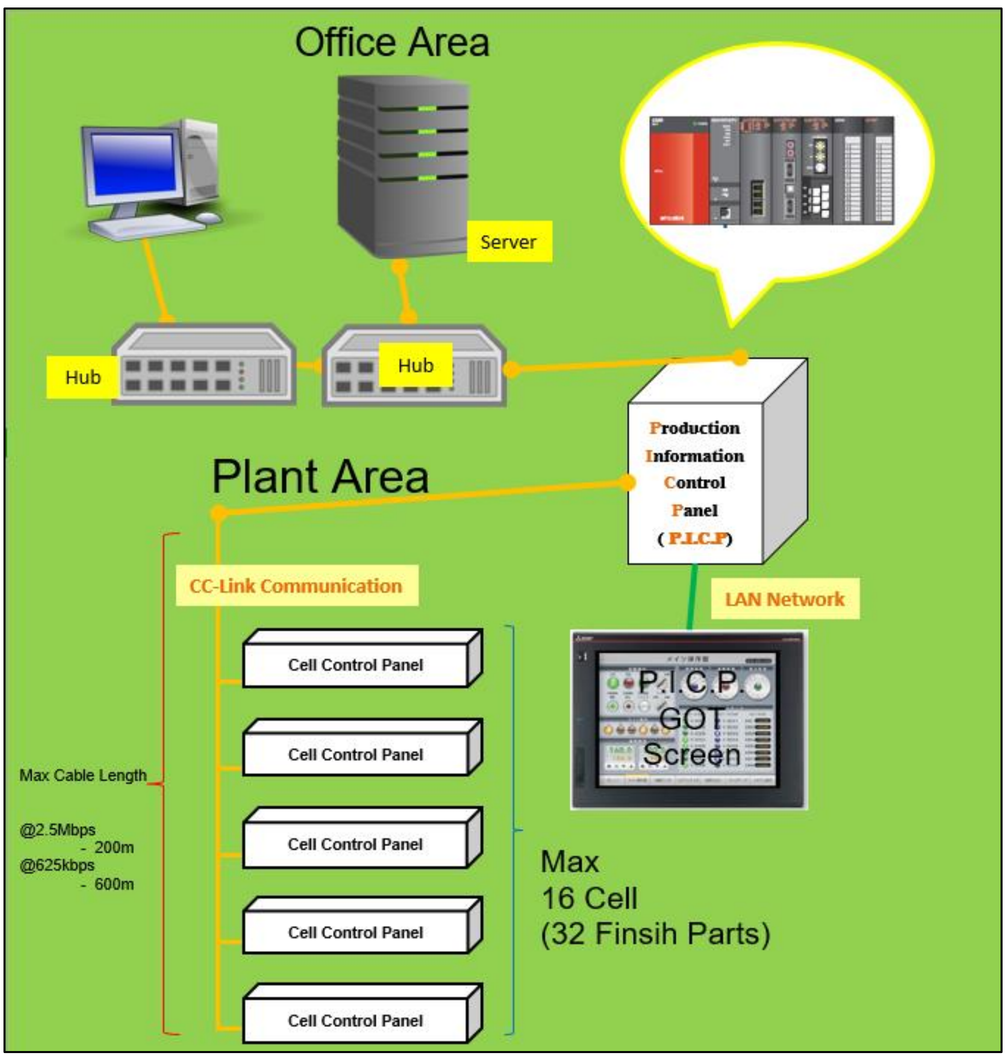

Figure 11

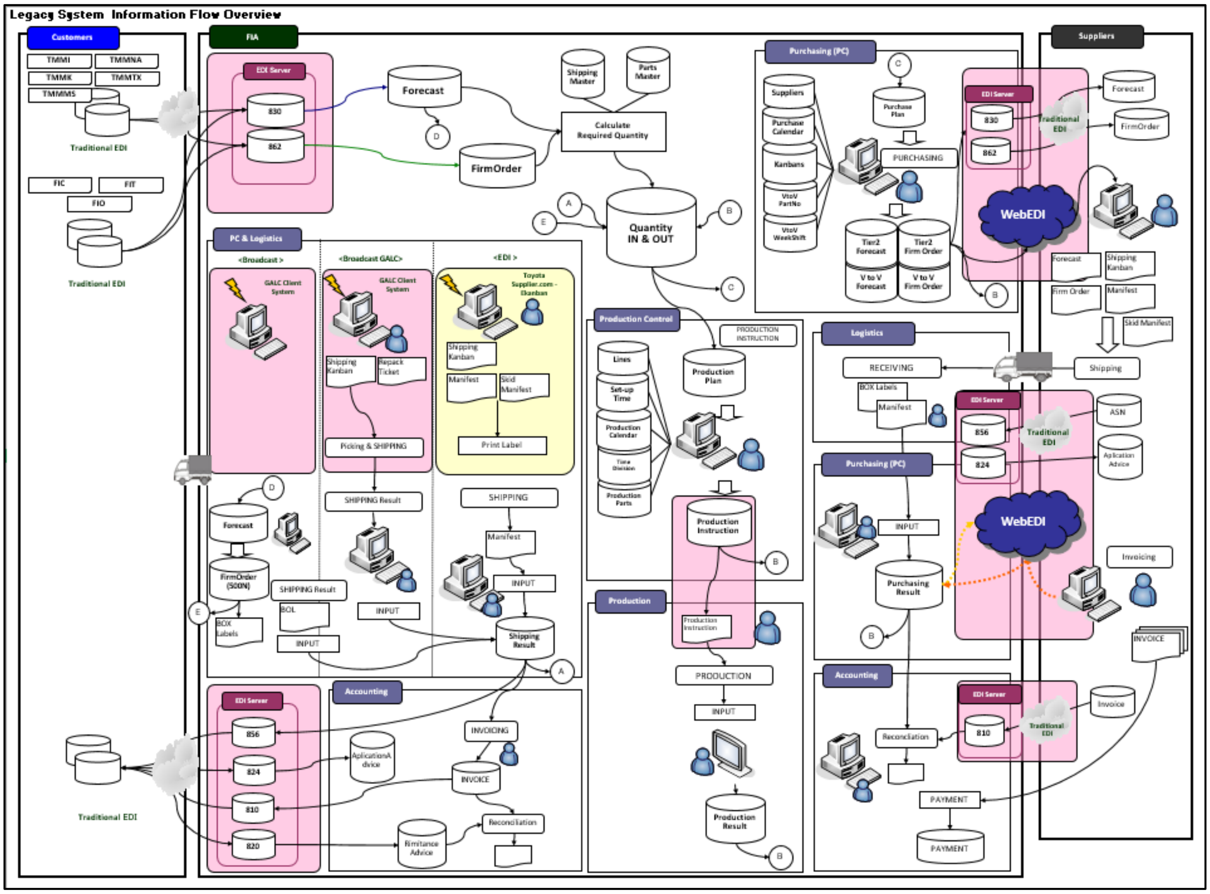

Figure 12

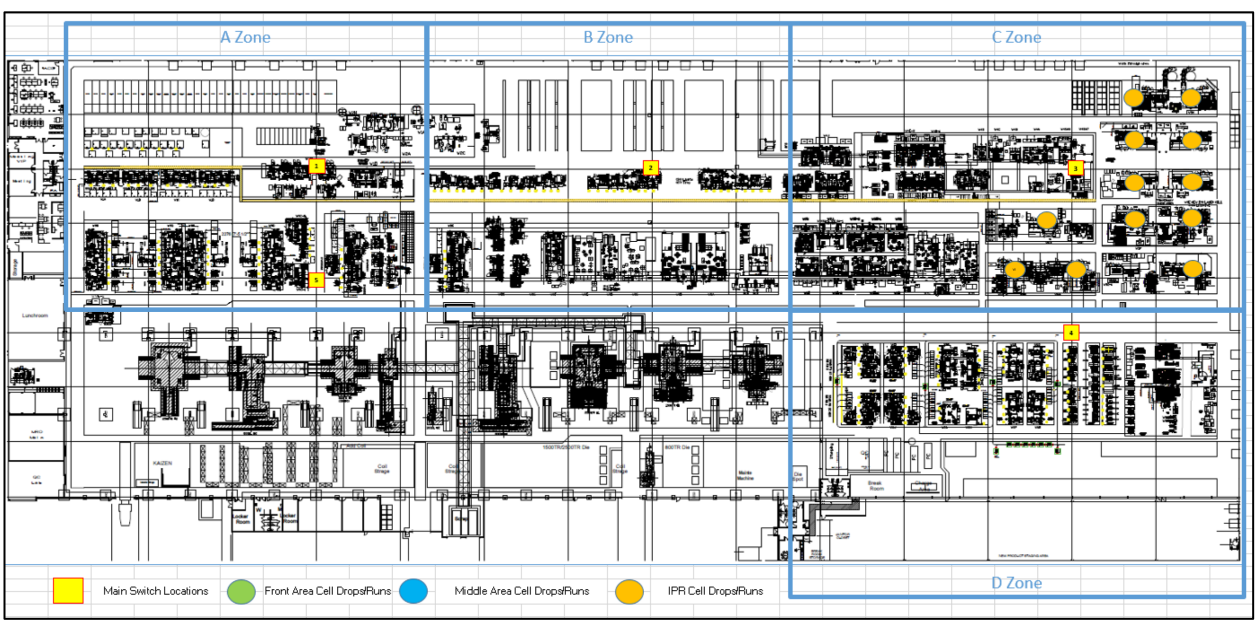

Figure 13

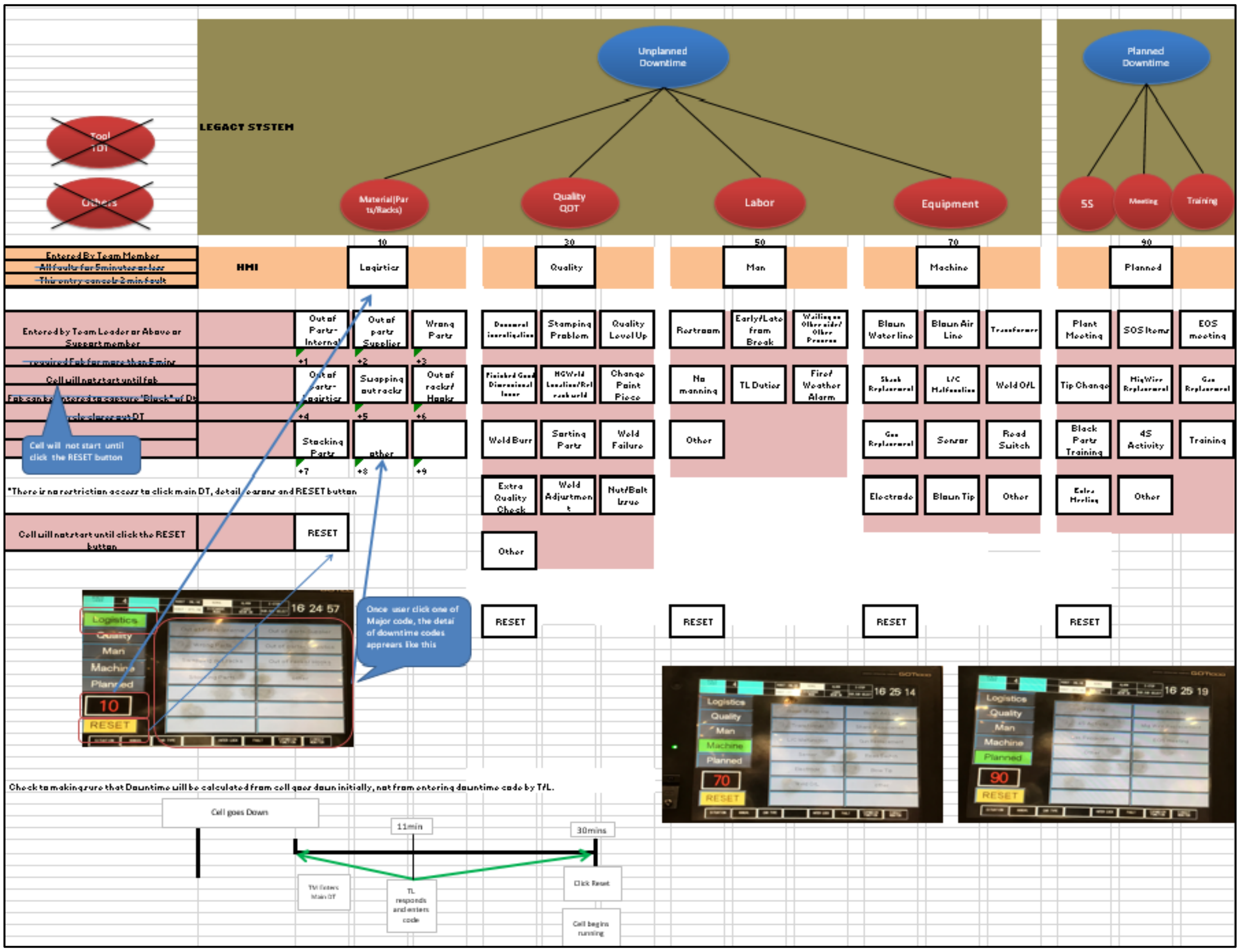
Unplanned Downtime
Planned Downtime
LEGACY SYSTEM
Material(Parts/Racks)
Quality QDT
Labor
Equipment
5S
Meeting
Training
HMI
Logistics
Quality
Man
Machine
Planned
Entered by Team Leader or Above or Support member
Out of Parts-Internal
Out of parts-Supplier
Wrong Parts
Stamping Problem
Quality Level Up
Restroom
Early/Late from Break
Blown Water line
Blown Air Line
Plant Meeting
SOS Items
EOS meeting
Swapping out racks
TL Duties
Fire/Weather Alarm
Weld O/L
Tip Change
Stacking Parts
other
Weld Burr
Sorting Parts
Weld Failure
Other
Sensor
Reed Switch
Black Parts Training
4S Activity
Training
Extra Quality Check
Weld Adjustment
Nut/Bolt Issue
Electrode
Blown Tip
RESET
Cell will not start until click the RESET button
Once user click one of Major code, the detail of downtime codes appears like this
Cell goes Down
11min
30mins
Click Reset
Cell begins running

Figure 14

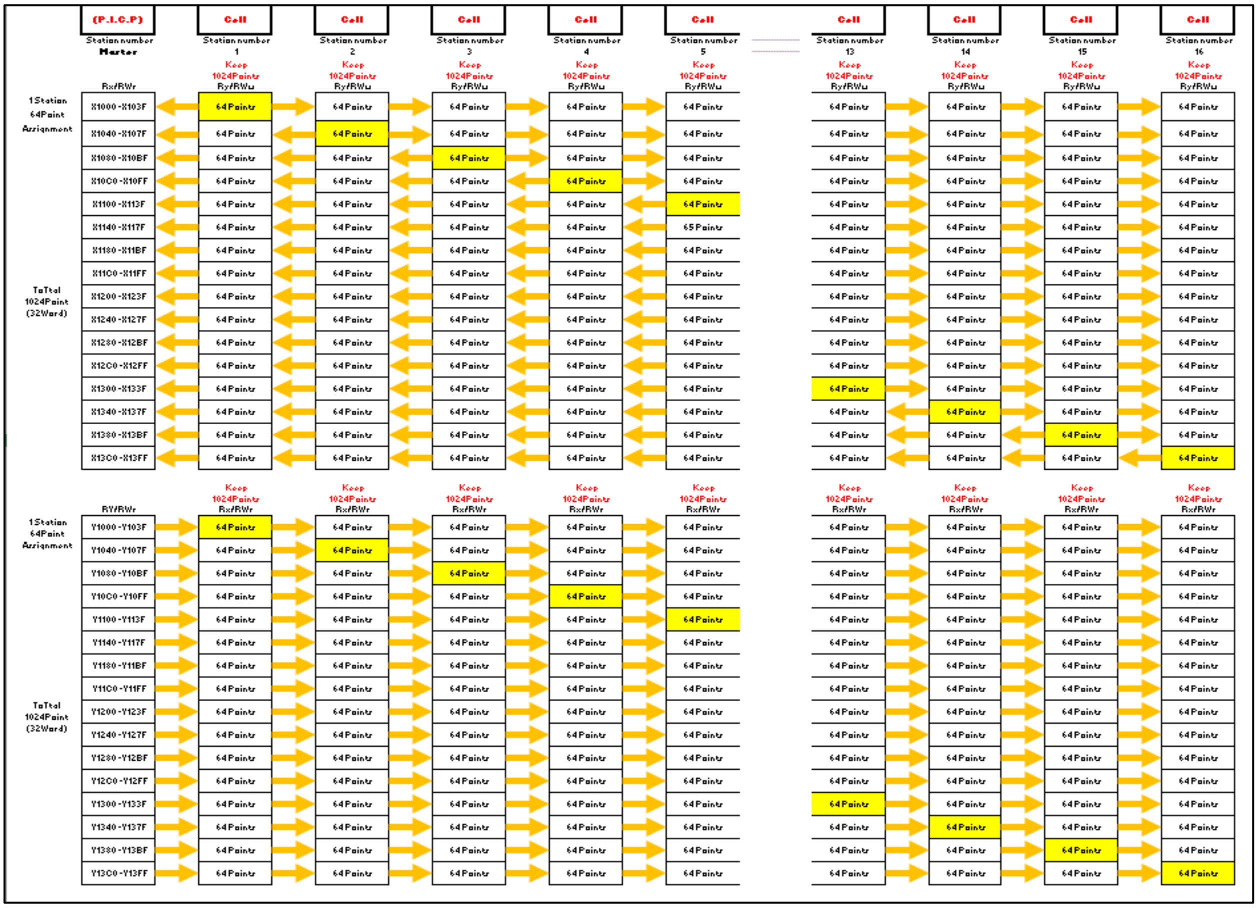
(P.I.C.P)
Station number
Marter
Cell
Station number
1
2
3
4
5
13
14
15
16
Koop
1024Pointr
Rx/RWr
Ry/RWu
1Station
64Point
Arrignment
ToTtal
1024Point
(32Word)
X1000 - X103F
X1040 - X107F
X1080 - X10BF
X10C0 - X10FF
X1100 - X113F
X1140 - X117F
X1180 - X11BF
X11C0 - X11FF
X1200 - X123F
X1240 - X127F
X1280 - X12BF
X12C0 - X12FF
X1300 - X133F
X1340 - X137F
X1380 - X13BF
X13C0 - X13FF
64 Pointr
RY/RWr
Rx/RWr
Y1000 - Y103F
Y1040 - Y107F
Y1080 - Y10BF
Y10C0 - Y10FF
Y1100 - Y113F
Y1140 - Y117F
Y1180 - Y11BF
Y11C0 - Y11FF
Y1200 - Y123F
Y1240 - Y127F
Y1280 - Y12BF
Y12C0 - Y12FF
Y1300 - Y133F
Y1340 - Y137F
Y1380 - Y13BF
Y13C0 - Y13FF

Figure 15

		Cell #1				Cell #2				Cell #3				Cell #4				Cell #5				Cell #6			
		RH Side		LH Side		RH Side		LH Side		RH Side		LH Side		RH Side		LH Side		RH Side		LH Side		RH Side		LH Side	
		Car Model	Line Tact	Car Model	Line Tact	Car Model	Line Tact	Car Model	Line Tact	Car Model	Line Tact	Car Model	Line Tact	Car Model	Line Tact	Car Model	Line Tact	Car Model	Line Tact	Car Model	Line Tact	Car Model	Line Tact	Car Model	Line Tact
	Actual Data	D00000	D00001	D00002	D00003	D00004	D00005	D00006	D00007	D00008	D00009	D00010	D00011	D00012	D00013	D00014	D00015	D00016	D00017	D00018	D00019	D00020	D00021	D00022	D00023
	ID Pint	D00100		D00101		D00102		D00103		D00104		D00105		D00106		D00107		D00108		D00109		D00110		D00111	
	Tact Count	D00200		D00201		D00202		D00203		D00204		D00205		D00206		D00207		D00208		D00209		D00210		D00211	

ID	Production	Cell #1				Cell #2				Cell #3				Cell #4				Cell #5				Cell #6			
		RH Side		LH Side		RH Side		LH Side		RH Side		LH Side		RH Side		LH Side		RH Side		LH Side		RH Side		LH Side	
		Car Model	Line Tact	Car Model	Line Tact	Car Model	Line Tact	Car Model	Line Tact	Car Model	Line Tact	Car Model	Line Tact	Car Model	Line Tact	Car Model	Line Tact	Car Model	Line Tact	Car Model	Line Tact	Car Model	Line Tact	Car Model	Line Tact
1	Prd. #1	ZR000000	ZR000001	ZR005000	ZR005001	ZR010000	ZR010001	ZR015000	ZR015001	ZR020000	ZR020001	ZR025000	ZR025001	ZR030000	ZR030001	ZR035000	ZR035001	ZR040000	ZR040001	ZR045000	ZR045001	ZR050000	ZR050001	ZR055000	ZR055001
2	Prd. #2	ZR000002	ZR000003	ZR005002	ZR005003	ZR010002	ZR010003	ZR015002	ZR015003	ZR020002	ZR020003	ZR025002	ZR025003	ZR030002	ZR030003	ZR035002	ZR035003	ZR040002	ZR040003	ZR045002	ZR045003	ZR050002	ZR050003	ZR055002	ZR055003
3	Prd. #3	ZR000004	ZR000005	ZR005004	ZR005005	ZR010004	ZR010005	ZR015004	ZR015005	ZR020004	ZR020005	ZR025004	ZR025005	ZR030004	ZR030005	ZR035004	ZR035005	ZR040004	ZR040005	ZR045004	ZR045005	ZR050004	ZR050005	ZR055004	ZR055005
4	Prd. #4	ZR000006	ZR000007	ZR005006	ZR005007	ZR010006	ZR010007	ZR015006	ZR015007	ZR020006	ZR020007	ZR025006	ZR025007	ZR030006	ZR030007	ZR035006	ZR035007	ZR040006	ZR040007	ZR045006	ZR045007	ZR050006	ZR050007	ZR055006	ZR055007
5	Prd. #5	ZR000008	ZR000009	ZR005008	ZR005009	ZR010008	ZR010009	ZR015008	ZR015009	ZR020008	ZR020009	ZR025008	ZR025009	ZR030008	ZR030009	ZR035008	ZR035009	ZR040008	ZR040009	ZR045008	ZR045009	ZR050008	ZR050009	ZR055008	ZR055009
6	Prd. #6	ZR000010	ZR000011	ZR005010	ZR005011	ZR010010	ZR010011	ZR015010	ZR015011	ZR020010	ZR020011	ZR025010	ZR025011	ZR030010	ZR030011	ZR035010	ZR035011	ZR040010	ZR040011	ZR045010	ZR045011	ZR050010	ZR050011	ZR055010	ZR055011
7	Prd. #7	ZR000012	ZR000013	ZR005012	ZR005013	ZR010012	ZR010013	ZR015012	ZR015013	ZR020012	ZR020013	ZR025012	ZR025013	ZR030012	ZR030013	ZR035012	ZR035013	ZR040012	ZR040013	ZR045012	ZR045013	ZR050012	ZR050013	ZR055012	ZR055013
8	Prd. #8	ZR000014	ZR000015	ZR005014	ZR005015	ZR010014	ZR010015	ZR015014	ZR015015	ZR020014	ZR020015	ZR025014	ZR025015	ZR030014	ZR030015	ZR035014	ZR035015	ZR040014	ZR040015	ZR045014	ZR045015	ZR050014	ZR050015	ZR055014	ZR055015
9	Prd. #9	ZR000016	ZR000017	ZR005016	ZR005017	ZR010016	ZR010017	ZR015016	ZR015017	ZR020016	ZR020017	ZR025016	ZR025017	ZR030016	ZR030017	ZR035016	ZR035017	ZR040016	ZR040017	ZR045016	ZR045017	ZR050016	ZR050017	ZR055016	ZR055017
10	Prd. #10	ZR000018	ZR000019	ZR005018	ZR005019	ZR010018	ZR010019	ZR015018	ZR015019	ZR020018	ZR020019	ZR025018	ZR025019	ZR030018	ZR030019	ZR035018	ZR035019	ZR040018	ZR040019	ZR045018	ZR045019	ZR050018	ZR050019	ZR055018	ZR055019
11	Prd. #11	ZR000020	ZR000021	ZR005020	ZR005021	ZR010020	ZR010021	ZR015020	ZR015021	ZR020020	ZR020021	ZR025020	ZR025021	ZR030020	ZR030021	ZR035020	ZR035021	ZR040020	ZR040021	ZR045020	ZR045021	ZR050020	ZR050021	ZR055020	ZR055021
12	Prd. #12	ZR000022	ZR000023	ZR005022	ZR005023	ZR010022	ZR010023	ZR015022	ZR015023	ZR020022	ZR020023	ZR025022	ZR025023	ZR030022	ZR030023	ZR035022	ZR035023	ZR040022	ZR040023	ZR045022	ZR045023	ZR050022	ZR050023	ZR055022	ZR055023
13	Prd. #13	ZR000024	ZR000025	ZR005024	ZR005025	ZR010024	ZR010025	ZR015024	ZR015025	ZR020024	ZR020025	ZR025024	ZR025025	ZR030024	ZR030025	ZR035024	ZR035025	ZR040024	ZR040025	ZR045024	ZR045025	ZR050024	ZR050025	ZR055024	ZR055025
14	Prd. #14	ZR000026	ZR000027	ZR005026	ZR005027	ZR010026	ZR010027	ZR015026	ZR015027	ZR020026	ZR020027	ZR025026	ZR025027	ZR030026	ZR030027	ZR035026	ZR035027	ZR040026	ZR040027	ZR045026	ZR045027	ZR050026	ZR050027	ZR055026	ZR055027
15	Prd. #15	ZR000028	ZR000029	ZR005028	ZR005029	ZR010028	ZR010029	ZR015028	ZR015029	ZR020028	ZR020029	ZR025028	ZR025029	ZR030028	ZR030029	ZR035028	ZR035029	ZR040028	ZR040029	ZR045028	ZR045029	ZR050028	ZR050029	ZR055028	ZR055029
16	Prd. #16	ZR000030	ZR000031	ZR005030	ZR005031	ZR010030	ZR010031	ZR015030	ZR015031	ZR020030	ZR020031	ZR025030	ZR025031	ZR030030	ZR030031	ZR035030	ZR035031	ZR040030	ZR040031	ZR045030	ZR045031	ZR050030	ZR050031	ZR055030	ZR055031
17	Prd. #17	ZR000032	ZR000033	ZR005032	ZR005033	ZR010032	ZR010033	ZR015032	ZR015033	ZR020032	ZR020033	ZR025032	ZR025033	ZR030032	ZR030033	ZR035032	ZR035033	ZR040032	ZR040033	ZR045032	ZR045033	ZR050032	ZR050033	ZR055032	ZR055033
18	Prd. #18	ZR000034	ZR000035	ZR005034	ZR005035	ZR010034	ZR010035	ZR015034	ZR015035	ZR020034	ZR020035	ZR025034	ZR025035	ZR030034	ZR030035	ZR035034	ZR035035	ZR040034	ZR040035	ZR045034	ZR045035	ZR050034	ZR050035	ZR055034	ZR055035

Figure 16

Manual input information

Impossible to divide	Item	# ob bits	Max of #	Current status	Note
	Cell #	8 bit	～255	80	
	Part #	4 bit	～7	312	Cell #にﾘﾝｸさせたData Baseがある
O	Name	10 bit	～1023	750	
O	Start SW	1 bit	～2	On-Off	
O	End SW	1 bit	～2	On-Off	
O	Unplanned Stop SW	1 bit	～2	On-Off	
O	# of Defect Parts	6 bit	～63	?	
O	DownTime Codes	7 bit	～127	Only Unpland 42	2 bit(E,Q,L,M) + 5 bit(20)
		38 bit			

Production Downtime Codes

Unplanned

Equipment		Quality	
E01	Blown Weld Tip	Q01	Stamping Defect
E02	Sensor adjustment/Change	Q02	Weld Nut Problem
E03	Nut/Bolt feed fault	Q03	Weld Bolt/Pin Problem
E04	Water Leak	Q04	Bad Arc Weld
E05	Air Leak	Q05	Bad Spot Weld
E06	Read Switch adjustment/Not reading	Q06	Bad Laser Weld
E07	Broken Guide Pin/Jig	Q07	Harmful Burrs
E08	Laser Gas Change	Q08	Excess Gap (Part Fit)
E09	Mig Gas Bottle Change	Q09	Sorting Parts
E10	Mig Wire Change	Q10	Waiting on Change Point Piece
E11	Mig Wire Tangled	Q11	Stop-Call-Wait
E12	Water Flow Problem/ Fault	Q12	**OTHER ISSUE**
E13	Part loading in Jig problem-Jig Problem		
E14	Mirror Cleaning		
E15	Loss of Power Cell or Machine		
E16	Plant Power Outage		
E17	Photo Eye Adjustment/Change		
E18	Fault -All Other		
E19	Light Curtain Not Working		
E20	**OTHER ISSUE**		

Labor		Material Shortages	
L01	Loading/Unloading issues	M01	Out of parts-None available at FIA
L02	Operator Error- Nutter Machine Fault	M02	Out of Parts- Logistics Process
L03	Unplanned Break (ex: Bathroom, Drink)	M03	Waiting on Finished Goods Containers
L04	Team Leader Duties	M04	Out of Parts-Production Sub
L05	Waiting on Team Leader	M05	Wrong Parts
L06	Waiting on Other Side to Catch Up	M06	**OTHER ISSUE**
L07	Operator Error - Light Curtain		
L08	Waiting on Maintenance Department come		
L09	Waiting on Quality Department to come		
L10	**OTHER ISSUE**		

Planned

Planned	
P01	Start/ End of Shift Meeting
P02	Start of Shift Checks
P03	Quality Checks other than Start of Shift
P04	FG Audits
P05	4S
P06	Training
P07	Meeting other than Start or End of Shift
P08	Weekly Electrode Change
P09	**Other Planned Downtime**

Figure 17

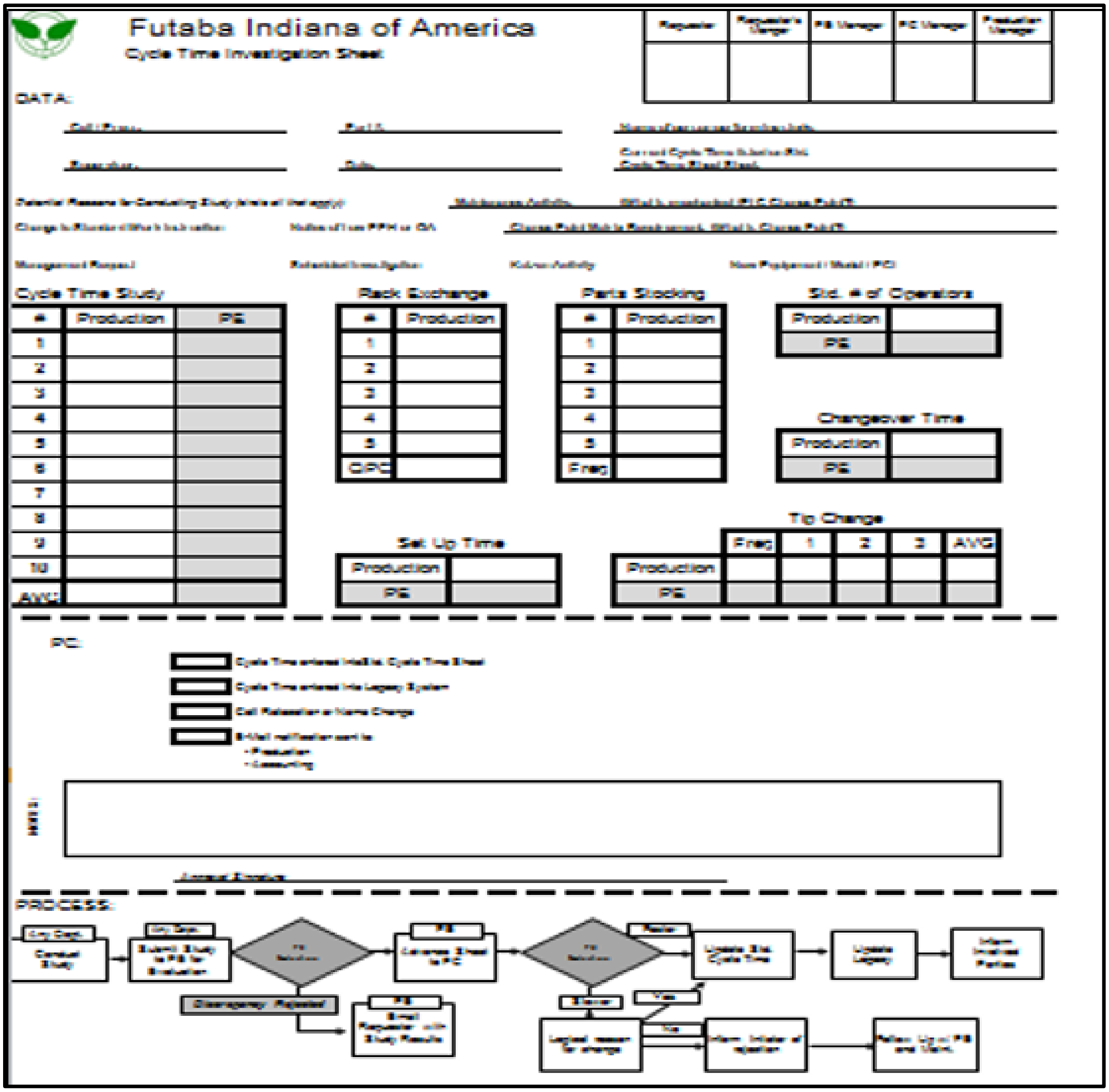
Futaba Indiana of America
Cycle Time Investigation Sheet
DATA:
Cycle Time Study
Rack Exchange
Parts Stocking
Std. # of Operators
Production
PE
Changeover Time
Tip Change
Freq
AVG
Set Up Time
PC:
PROCESS:

Figure 18

PLC Schedule

Cell No	PLC Series	Convert to Q (Program)	Convert to Q (Hardware)	Test	Install Program	Wiring Network Cable	Test (between Production Control Panel-Master and each cell PLC)	Monitor (GOT)	Monitor Size (inch)	T/L Allocation
W5A	A	Complete	Complete	Complete	Complete	Complete	Complete	Mitsubishi	15	A
W5B	A	Complete	Complete	Complete	Complete	Complete	Complete	Mitsubishi (Serial) Complete	15	
W5C	A	Complete	Complete	Complete	Complete	Complete	Complete	Mitsubishi	15	B
W5D	A	Complete	Complete	Complete	Complete	Complete	Complete	Mitsubishi (Serial) Complete	15	
W5E	Q	N/A	N/A	Complete	Complete	Complete	Complete	Mitsubishi	13	
W5F	Q	N/A	N/A	Complete	Complete	Complete	Complete	Mitsubishi	13	
W5G	A	Complete	Complete	Complete	Complete	Complete	Complete	Mitsubishi	13	
W5L	Q	N/A	N/A	Complete	Complete	Complete	Complete	Mitsubishi	13	A
W5M	Q	N/A	N/A	Complete	Complete	Complete	Received Data (Not completed yet)	Mitsubishi	13	
W5K	Q	N/A	N/A	Complete	Complete	Complete	Complete	Mitsubishi	13	C
W6A	A	Complete	Complete	Complete	Complete	Complete	Complete	Proface (will upgrade Mitsubishi Network)	13	
W6B	A	Complete	Complete	Complete	Complete	Complete	Complete	Proface (will upgrade Mitsubishi Network)	13	
W6D	Q	N/A	N/A	Complete	Complete	Complete		Mitsubishi (Serial) Complete	13	D

Figure 19

Total Project Cost	
KDDI	$86,695.00
McMaster-carr	$1,203.42
Allied Electronics	$392.86
Lowes	$79.09
Sonitrol	$9,714.00
Valley Electric	$7,665.00
PTS	$74,781.40
PTS	$22,269.00
Total	$202,799.77

Investment ROI in 3 Years

Daily F/Gs Inventory

Shift	Avg # of Employees	Hours to count F/Gs	Total Hrs
Blue	6	0.5	3
Gold	2	0.5	1
Total Daily hours worked			4

Total Cost for Daily inventory

Days/yr x Total Hrs/Day x Avg TM rate = $25,384.62

Quarterly Plant Inventory

Shift	Avg # of Employees	Hours to Count Parts	Total Hrs
Blue	100	4	400

Total Cost for Quarterly inventory

4/yr x Total Hrs/Inventory x Avg TM rate = $42,307.69

Avg TM wage rate	$26.44
Avg Working Day/yr	240
Avg TM	55000
Annual Hours @ 40/Week	2080

$67,692.31