Implementation of an Automated OEE Scada System on a New Manufacturing Line

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Abstract

A need for capturing performance for a manufacturing line was fulfilled by implementing an Overall Equipment Effectiveness (OEE) automated system in a manufacturing line. It was important to understand the OEE metric and use the necessary Lean tools (such as PQPR (Product Quality Process Routings), Standard Work, and Daily Management) to characterize and optimize the implementation. An easy-to-use system was successfully implemented, delivering historical data collection, providing performance health indicators, and highlighting improvement opportunities. Additionally, integration into existing Daily Management practices was undertaken to ensure consistent monitoring cadence. The process taken to implement the system is captured in this research.

Introduction

An introduction of a new manufacturing line intended to surpass current operational performance highlights a need to measure and optimize line performance. Using the Overall Equipment Effectiveness (OEE) metric to serve such purpose, an automated OEE Supervisory Control and Data Acquisition (SCADA) system is intended to provide on-demand accurate OEE measures of the newly introduced manufacturing line.

Background

Overall Equipment Effectiveness (OEE) is a measuring instrument first introduced by Seiichi Nakajima as part of the Total Productive Maintenance (TPM) concept [1]. OEE quantifies how well a manufacturing unit performs relative to its designed capacity, during the periods when it is scheduled to run [2]. OEE is composed of the product of three indicators: Availability, Capacity of Performance, and Quality (1).

$$OEE = Availabity \times Performance \times Quality \quad (1)$$

These elements isolate the six big losses as per Nigasaki: Equipment failure, Setup and adjustment, Minor Stoppages, Reduced speed, Defects in the process and Reduced yields [3]. Vorne Industries Inc is a company dedicated to providing productivity enhancements for manufacturing companies since 1970 [4]. VorneTM XL OEE monitoring system offers easy to install machine interaction sensors to collect machine status directly from the equipment. With the use of a barcode scanner, operator interactions are simple and fast to provide downtime reasons and yield information.[5]

Problem

This research was performed to provide a tool with clear insight into prioritizing issues worth addressing based on data-driven analysis of a manufacturing line performance. The focus was to implement a robust and reliable OEE data gathering system along with the standard work and sustainment measures to maintain its relevance. As with any change, engaging management, and the involved personnel on the value-added aspects of this implementation was key to success.

Methodology

The first step in this research was to understand and characterize the process. The OEE system needed accurate signals representing the right status of the manufacturing cell (such as running, stopped, part count, etc.). A Product Quantity Process Routing (PQPR) analysis was performed to outline routing variations and determine where would be the right machine to retrieve the signals from. Each of the product's routings were assessed to determine ideal rates for each of the product configurations. Cycle studies using Standard Work Combination Sheets were performed to confirm ideal rates.

The other aspect characterized, related to the Availability metric, were downtime reasons associated with the process. It was important to have downtime reasons specific and relevant to the process so that the retrieved reports had meaningful information. Existing process downtime reasons were loaded into the system and refined along the implementation of the system.

The third aspect considered was non-conformances categories and how to input into the system.

Once the established prerequisites were performed, the system was installed and commissioned (including training the associates involved in the manufacturing process).

Alongside the system implementation, daily management practices (reports, metrics, data gathering) were assessed and the new system was merged with existing practices. The existing process consisted of an SQDIP (Safety, Quality, Delivery, Inventory, and Productivity) daily management meeting at the manufacturing line, usually 5-10 minutes per line. OEE discussions were consolidated complementing existing metrics in scope with automated reports from the system. A Standard Work Kaizen on Daily Management for the specific line was carried out for this purpose.

Results and Discussion

The first decision to be made was around where the display board was to be installed. It needed to be appealing and obvious as it would be presenting real-time status of the line. It also needed to serve as an Andon (visual alert) signal obvious to supporting departments when a problem arises in the line. As shown in Figure 1, a location above the manufacturing cell facing the main walkway of the shop floor served the purpose.

Figure 1: Installed Board

As part of the process characterization, a PQPR was performed to understand product variation and optimize placing of the tracking signals to implement. It was important to identify common processes and bottlenecks to have an accurate tracking of part counts, cycle time and downtime occurrences. It was also important to map the process to understand where non-conformances were generated to implement scrap reporting near the point of use.

Based on the PQPR analysis, shown in Figure 2, it was concluded that the end capping process served a common process within all variations. Therefore, drawings from the end capping machine were analyzed to understand where the signals were to be taken from.

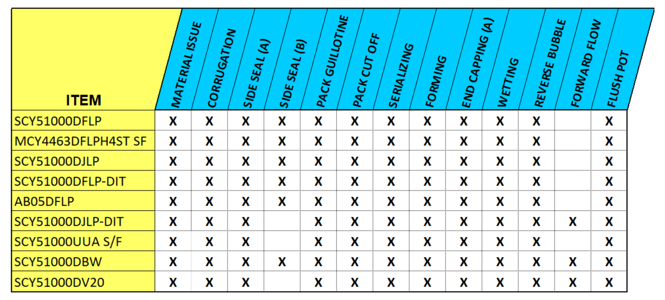

Figure 2: PQPR Analysis

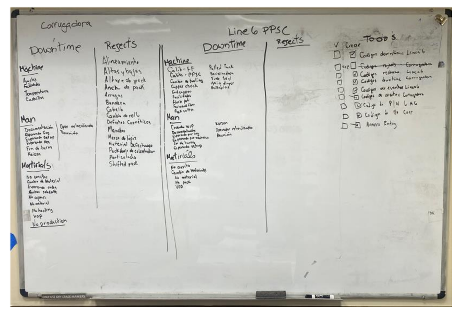

Figure 3: Brainstorm Workshop

The end capping step proved to be the bottleneck process hence a downtime tracking station was installed next to the end capping station. This station also served as a batch setup station to initialize different product configurations. This is needed to accurately determine performance as cycle time varies from product to product.

It was also found that the integrity testing process was predominantly the step where non-conformance was detected. A non-conformance station was placed by the integrity testing equipment.

Once all installation was completed, it was time to program all product variants, downtime reasons and reject reasons into the system. As shown in Figure 3, a workshop was performed involving line operators to capture the requirements.

Part numbers were created along with cycle information (ideal cycle time. allowances for recording downtime, etc.) A part number selection print (see Figure 4 below) was done with barcodes for the operator to scan from. Special events needing to be entered (such as lunch break, no orders, etc.) were also added to the printout. Similar printout was performed for downtime and reject codes (Figure 5 and Figure 6).

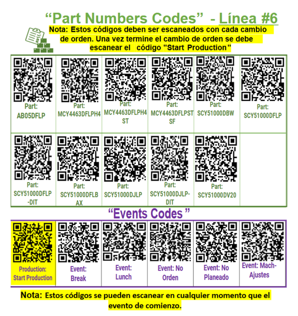

Figure 4: Part Number Codes Printout

Figure 5: Downtime Codes Printout

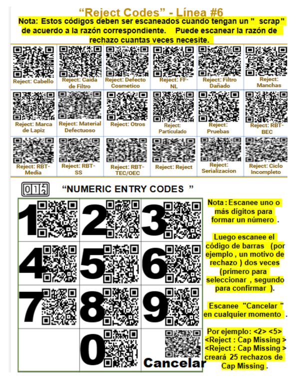

Figure 6: Reject Codes Printout

Operators were then trained in the correct use of the system and the needed interactions. The intention was to substitute manual tracking, so no additional tasks were introduced in the process.

The last step was around incorporating the data into the Daily Management practices. A Microsoft Excel automated script (shown in Figure 7) was created to match the existing format.

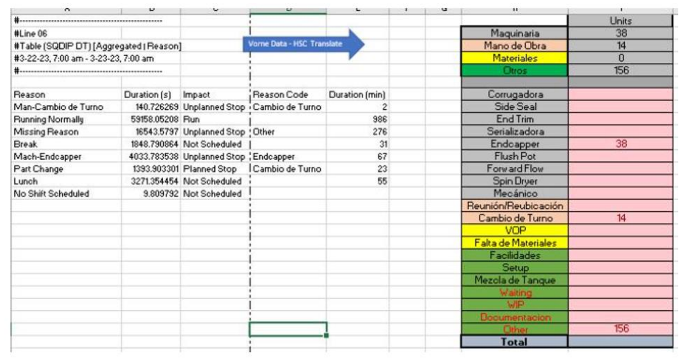

Figure 7: Excel Script

Conclusions

The OEE system implementation was performed successfully. During the piloting phase, manual entries (such as output, scrap, and down time reasons) were compared to the automated generated data and were found to be equivalent. Operators' interactions were reduced from an average of 5 minutes per hour to 3.5 minutes per hour, a 30% reduction. SQDIP daily management meeting preparation was also reduced as manual data entry from the Hourly Scorecards into the SQDIP form was no longer required. After a few weeks passed and the system used provided more accurate data, a baseline average OEE calculation of 68% (72% Availability, 98% Performance, and 96% Quality) for the new line was established. Although this OEE is far from ideal, the key deliverable from the implementation was to provide accurate OEE data and it was successfully achieved.

Future Work

The next step for this implementation is to establish a process to translate captured deficiencies into improvement initiatives using the PDCA tool. It is meant for the Operations team to lead this effort as the OEE metric owner. Downtime reasons, Scrap and Rework failure modes are to be Pareto (automated report) to establish prioritization on issues to target. A project funnel for each of the contributing teams is to be defined from the opportunities. As the initiatives are active, the PDCA methodology will be used to track the status, and later, the improvement achieved. As improvements are proven, the bar goes higher.

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