Stamping Tooling Preventive Maintenance Project

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Abstract *— Eaton Corporation's Electrical Sector, a global leader in power management solutions, faces a critical challenge in the Stamping Department's tooling equipment maintenance. The absence of a defined Preventive Maintenance Plan (PMP) has led to frequent breakdowns, increased downtime, and production inefficiencies. This paper presents a comprehensive approach to address this challenge, incorporating insights from literature on tools and dies preventive maintenance, Lean Six Sigma principles, and a detailed affinity analysis. The data-driven selection of cost-driver tools, their prioritization, and the development of a tailored PMP are discussed. The implementation of proactive measures, such as evaluating tooling cycles, generating maintenance tags, and designating dedicated personnel, contributes to improved efficiency. The future state envisions a preventive tooling handling process, reducing troubleshooting and downtime. Achievements include projected savings of $314k/year through improved Overall Equipment Efficiency (OEE), reduced support hours, and optimized Tool Room processes. The conclusions highlight the project's success and propose further enhancements to overall production.*

Key Terms *— Affinity Analysis, Downtime, Non-Conformance, Overall Equipment Efficiency, Production Troubleshooting, Root Cause Analysis*

INTRODUCTION

As a company committed to powering businesses worldwide, Eaton's Electrical Sector plays a pivotal role in delivering safe, reliable, and efficient electrical solutions for a wide range of industries. It offers a comprehensive portfolio of electrical products designed to meet the diverse needs of its customers. These products include electrical distribution systems, circuit breakers, switchgear, panelboards, and power management software. Eaton's electrical products find applications in various sectors, including commercial buildings, data centers, industrial facilities, healthcare, and utilities.

Within the Electrical Sector, the Stamping Department holds significant importance in ensuring the production of high-quality electrical components. The department utilizes specialized machinery and equipment to shape and form metal sheets into precise components used in various electrical applications. Maintenance is of utmost importance to ensure uninterrupted production, minimize downtime, and uphold product quality. By implementing regular maintenance procedures, Eaton can detect and address potential equipment failures or inefficiencies before they escalate into significant issues. This proactive approach helps prevent unexpected breakdowns, production delays, and costly repairs.

Objective

The absence of a well-defined Preventive Maintenance Plan (PMP) for the tooling equipment has resulted in excessive downtime, significantly affecting production efficiency. Therefore, the objective of this project was to develop a comprehensive PMP that can effectively address the maintenance requirements of the tooling equipment.

LITERATURE REVIEW

Eaton Corporation's Stamping Department's tooling equipment lacked a clear preventive maintenance plan (PMP), resulting in major production efficiency difficulties and increased downtime. Insights from industry expertise highlighted the importance of balancing fundamentals and real-world practices in tool

engineering and die design. This was essential to understand basic terminology of die components and classifications, establish effective maintenance protocols and materials used on each case within the factory's Stamping Department [1].

Addressing challenges specific to sheet metal stamping, a step-by-step guide for implementing preventive maintenance processes was identified, emphasizing strategies and procedures, such as checklists going from visual inspections evaluations to tool setups and sample runs, for large body-panel stamping dies such as the ones within the factory [2]. Additionally, practical guidance from industry associations and metal fabrication individuals emphasized the importance of knowledge-sharing and proactive maintenance to enhance tool life and operational performance by compiling a To-Do manual for better care of tooling in which was used as benchmark to generate a Preventive Maintenance checklist adjusted to Eaton's standards [3].

Expanding the perspective to encompass broader manufacturing principles, integration of Lean Six Sigma methodologies, such as analysis integration tools like flowcharts, cause & effect diagrams and pareto charts [4][5], provided a holistic approach to enhancing production efficiency and quality improvement. By integrating principles from Lean and Six Sigma, Eaton Corporation's team aimed to implement a comprehensive preventive maintenance plan as part of a broader strategy to enhance overall efficiency and reliability.

DATA COLLECTION

Affinity Analysis

During the process of selecting and prioritizing a specific tool for the Preventive Maintenance Plan (PMP), an affinity analysis was utilized to identify the business impact tools and focus on their Preventive Maintenance (PM). Figure 1 shows potential factors to consider tool priority for the PMP. These factors are:

- **Demand:** The fluctuating demand for products in the Stamping Department directly impacts on the workload and stress on the equipment.
- **Tool Repair Frequency:** Tools that required frequent repairs indicated potential reliability issues and can contribute to extended downtime.
- **Production Troubleshooting:** Certain tools were more prone to causing production troubleshooting issues, resulting in delays and interruptions.
- **Quality Non-Conformances:** Tools with a higher incidence of quality non-conformances directly impacted product quality and customer satisfaction.

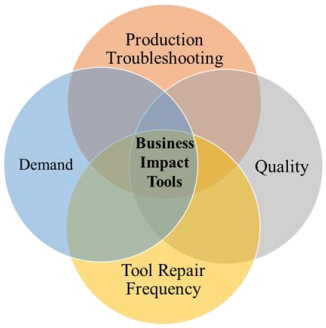

Figure 1
Business Impact Tools Factors

A Factor Rating Analysis was generated using the above factors to determine the top drivers within the Stamping Department. By considering these factors and by conducting a comprehensive analysis, the most suitable tools to start with the PMP were summarized in Figure 2. Note that the analysis was based on a 10-month data history collection.

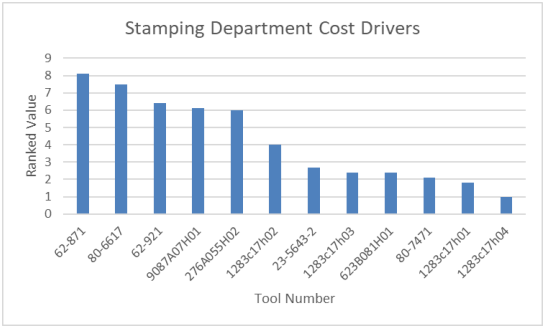

Figure 2
Cost Driver Tools Pareto Chart

Based on the above analysis, the top twelve driver tools for preventive maintenance were selected based on their frequency of use, repair requirements, troubleshooting incidents, and impact on product quality. These tools play a crucial role in meeting demand, maintaining production efficiency, and ensuring high-quality output. Prioritizing their maintenance helped improve overall equipment reliability, minimize downtime, and maximize production output in the Stamping Department.

TOOLS USED

By shifting focus towards preventive maintenance, the project aimed to enhance the Stamping Department's manufacturing capabilities, improve overall productivity, and alleviate the workload in the Tool Room. This project addressed the existing inefficiencies and challenges associated with the current tool maintenance approach, ensuring equipment reliability, reducing unplanned downtime, and maximizing operational efficiency. Through the implementation of proactive maintenance practices, the project endeavors to create a robust and sustainable tool maintenance framework that will positively impact the department's performance.

Current State

As shown in the current state flowchart in Figure 3, the tooling handling process was a reactive one expecting troubleshooting during production. Thus, ultimately sending the tool for repair at the Tool Room causing downtime at the Stamping Department and increment in labor hours in the Tool Room.

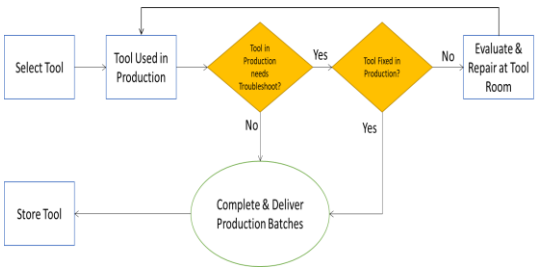

Figure 3
Tool Handling Process Current State Diagram

Root Cause Analysis

In this cause-and-effect diagram, shown in Figure 4, the main cause identified is "Tool and Die Causes of Downtime" within the Stamping Department. It is further divided into five primary categories: Insufficient Lubrication, Wear and Tear, Tool/Die Breakage, Tool/Die Design Issues, and Lack of Regular Maintenance. Each category then presents specific causes related to tool and die maintenance that contribute to downtime. These causes include issues such as inadequate lubrication practices, misalignment, excessive wear, tool/die breakage, design flaws, and lack of regular maintenance activities. Identifying these causes helped the department to address the root issues to implement targeted solutions to reduce downtime and improve overall productivity.

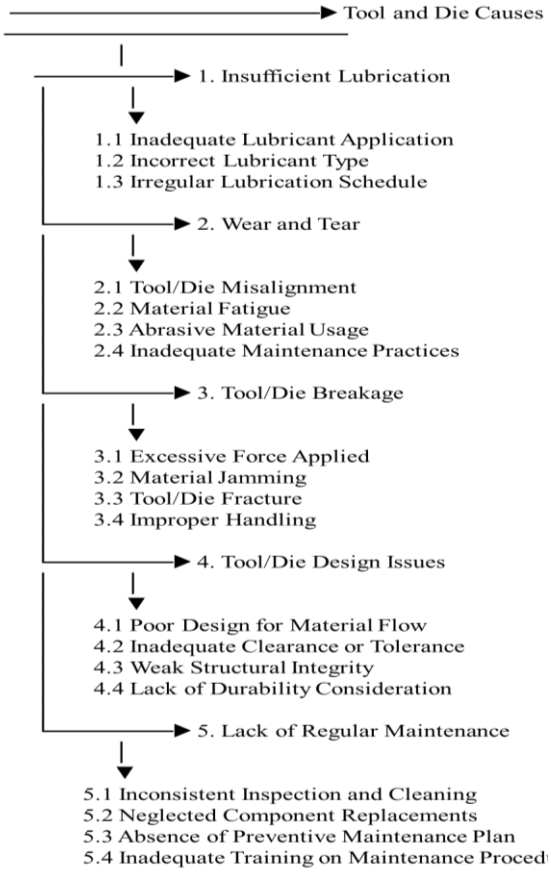

Figure 4
Tool & Dies Downtime Cause & Effect Diagram

IMPROVEMENTS

Future State

As shown in the future state flowchart in Figure 5, the tooling handling process shifted to a preventive one, minimizing troubleshooting during production due to tool faults. Hence, improving downtime at the Stamping Department and ultimately a reduction in labor hours in the Tool Room. Notice that a Preventive Maintenance (PM) cycle target was incorporated to trigger preventive maintenance on the tools. The cycle target on each tool varies depending on the average cycle fault or when the tool breaks after a certain number of parts are made. Also, this model assumed no production troubleshooting and other minor tasks due to tool fault after initial preventive maintenance has been completed.

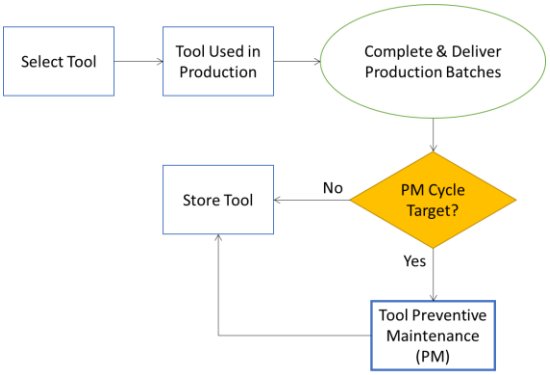

Figure 5
Tool Handling Process Future State Diagram

Solutions & Action Plan

To implement the Preventive Maintenance Plan (PMP) in the Stamping Department, a series of actions were undertaken to enhance the maintenance process and reduce downtime.

Firstly, the cost-driver tooling preventive maintenance cycle targets were evaluated by considering factors such as operator feedback, production data, and insights from the Tool Room. This analysis helped determine the optimal maintenance intervals for different tools, ensuring timely maintenance to prevent breakdowns.

In addition, to effectively schedule and track preventive maintenance, tags and/or logs, as shown in Figure 6, were generated. These tags helped identify tools due for maintenance, ensuring no tool was overlooked or neglected. Additionally, alerts were set up in the production system after a certain number of cycles, notifying the relevant personnel that preventive maintenance was due.

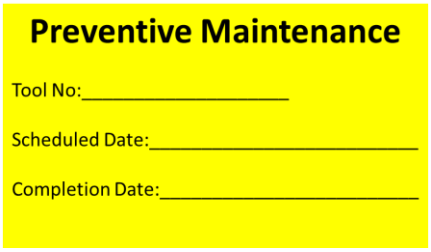

Figure 6
Tool PM Tag

Another solution implemented was the identification and stocking of standard tooling spare parts. By keeping essential components like bushings, springs, punches, pins, and others in stock, the department could quickly replace worn-out or damaged parts during preventive maintenance, minimizing downtime and streamlining the maintenance process. A Spare Part Consignment Program was carried out to keep spare parts in-house. Various Request for Proposals (RFPs) were sent out to specific suppliers to reach a possible future agreement. To streamline the preventive maintenance tasks, dedicated Tool & Die Makers were designated for performing the PM jobs. These personnel were either hired or trained specifically for repetitive maintenance tasks, ensuring efficiency and expertise in carrying out the maintenance activities.

Also, the stamping department and tool room layouts were evaluated, and designated tool pickup areas were established. This evaluation aimed to optimize the flow of tools between the stamping department and the tool room, ensuring that tools were readily available for maintenance and reducing the time required for tool pickup or drop-off.

Furthermore, to ensure thorough and consistent maintenance, a comprehensive PM checklist was created. This checklist was developed based on

research, cause and effect analysis, and feedback from experienced Tool & Die Makers, outlined the specific tasks and inspections to be performed during preventive maintenance, providing a standardized approach, and minimizing the chance of overlooking critical maintenance steps.

By implementing these solutions, the Stamping Department improved the preventive maintenance process, enhanced tool availability, and streamlined maintenance tasks. These actions contributed to minimizing downtime, maximizing productivity, and ensuring the smooth operation of the department's tooling equipment.

ACHIEVEMENTS & CONCLUSIONS

In summary, the Preventive Maintenance Project for Tool & Dies in the Stamping Department yielded significant achievements, resulting in substantial enhancements to overall operational efficiency and cost savings. The project's successes include projected daily savings of 2.7 hours in tooling production troubleshooting, equating to a notable 6% improvement in Overall Equipment Efficiency (OEE) due to availability and an annual cost reduction of $58k. Moreover, support hours for tooling production troubleshooting were projected to decrease by an average of 1 hour per unit, translating to an annual cost saving of $31.8k.

The Tool Room Improvement aspect of the project anticipated a remarkable 61% reduction in labor hours, equivalent to the workload of one dedicated stamping employee, after the initial cycle of Preventive Maintenance on all tools. This reduction is estimated to result in an annual cost saving of $219k. Additionally, there is a projected 37.5% decrease in forklift travel time, amounting to $5.4k annually, following the implementation of a new layout. The introduction of a Spare Part Consignment Program is expected to avoid an average of one week of spare parts waiting time, leading to a weekly cost avoidance of $3.4k.

In total, these achievements culminate in an impressive $314k annual savings after full implementation. The success of the Preventive Maintenance Project sets the stage for further improvements in the Stamping Department's production processes.

To amplify the positive impact on stamping production, several recommendations were proposed. Firstly, investing in state-of-the-art machinery and tooling to enhance efficiency, precision, and productivity could significantly elevate the production process. Secondly, focusing on refining second operations, such as post-stamping activities or value-added processes, could optimize overall output and alleviate bottlenecks. Thirdly, implementing comprehensive employee training programs to augment technical skills, safety awareness, and problem-solving capabilities could contribute to a more proficient and efficient workforce. Lastly, adopting advanced supply chain management strategies, including vendor management programs and improved inventory control, could ensure the timely availability of materials and reduce lead times, ultimately boosting production efficiency.

By integrating these recommendations with the accomplishments of the Preventive Maintenance Project, the Stamping Department is poised to further elevate its productivity, efficiency, and cost-effectiveness. This strategic approach will strengthen its position in the industry, allowing for the delivery of high-quality products to customers.

REFERENCES

[1] Boljanovic, V., & Paquin, J.R. (2005). Die Design Fundamentals.

[2] Ulrich, T. J., & Ulrich, S. E. (2012). Die Tooling Preventive Maintenance for the Sheet Metal Stamping Industry: A Comprehensive, Step-by-Step Guide to Control Your Sheet Metal Stamping Process.

[3] North American Die Casting Association. (2023). Care and Maintenance of Die Casting Dies Manual & Checklist.

[4] George, M. L. (2002). Lean Six Sigma: Combining Six Sigma Quality with Lean Production Speed 1st Edition.

[5] Liker, J. (2020). The Toyota Way, Second Edition: 14 Management Principles from the World's Greatest Manufacturer 2nd Edition.