

Optimizing Paperboard Coating Processes at Stellar Packaging Solutions: A Six Sigma DFSS Approach

Abstract

Stellar Packaging Solutions Limited (Stellar) faces quality challenges in its white pigment coating process for paperboard cartons. Patchy coatings and unidentified reel joints lead to printing errors, material waste, and customer dissatisfaction. This paper proposes the implementation of Six Sigma's Design for Six Sigma (DFSS) methodology to address these concerns. By establishing a documented process, implementing standardized defect identification methods, and focusing on root cause analysis, the DFSS approach aims to minimize patchy coatings, ensure consistent joint identification, and enhance overall process efficiency.

Traditional DMAIC vs. DFSS Approach

While the Define-Measure-Analyze-Improve-Control (DMAIC) cycle forms the core of Six Sigma, it is not entirely suitable for Stellar's situation. The coating and slitting (C&S) machine currently lacks a documented process, rendering the "Define" phase incomplete. Additionally, Six Sigma typically focuses on improving existing processes. In Stellar's case, the objective is to not only optimize but also formally design a robust C&S operation. Therefore, the DFSS methodology provides a more fitting framework.

DFSS excels in designing and optimizing new or existing processes, aligning perfectly with Stellar's need to create a documented and improved C&S process. Furthermore, it emphasizes preventing defects from occurring in the first place, a critical aspect for minimizing patchy coatings.

DFSS Implementation at Stellar Packaging Solutions

1. Define

- **Customer Requirements:** Stellar's primary customer is the internal printing department. Their requirements are consistent, high-quality coated reels with clearly identifiable joints to minimize printing errors and waste.

- **Project Critical To Quality (CTQs):** These are measurable characteristics that define process success:
 - Percentage of reels with patchy coatings.
 - Percentage of reels with unidentified joints.
 - Reel waste generated due to defects.
- **Project Deliverables:**
 - A documented C&S machine process for consistent operation.
 - Standardized procedures for identifying patchy coatings and joints during production.
 - Defined control measures for ongoing process monitoring.

2. Design

- **Process Mapping:** A detailed flow chart will be created outlining each step in the C&S machine operation. This will include inputs (raw board, coating materials), process steps (coating application, drying, slitting), and outputs (coated reels).
- **Failure Mode and Effect Analysis (FMEA):** A proactive approach will be taken by identifying potential failure modes (patchy coatings, unidentified joints) and their effects on downstream processes (printing errors, waste). Severity, occurrence, and detection of each failure mode will be analyzed to prioritize risk mitigation strategies.

3. Verify

- **Pilot Testing:** The designed process will be implemented on a small scale, producing a limited number of coated reels. The CTQs will be closely monitored during this pilot run, allowing for real-time analysis of the effectiveness of the new procedures in identifying patchy coatings and joints.
- **Statistical Analysis:** Tools like control charts will be utilized to monitor the performance of the pilot run. Any variations or trends in defect rates will be identified and addressed before full-scale implementation.

4. Analyze

- **Cause-and-Effect Diagram (Ishikawa Fishbone):** Data collected during the pilot run will be analyzed using an Ishikawa Fishbone diagram to identify potential causes of patchy coatings. Common causes might include power fluctuations, malfunctioning oil-based heaters, or variations in coating viscosity.
- **Pareto Analysis:** The identified causes will be prioritized based on their frequency of occurrence using a Pareto Analysis. This will ensure that efforts are focused on eliminating the factors contributing to the majority of patchy coatings.

5. Improve

- **Implement Solutions:** Based on the findings from the Analyze phase, targeted solutions will be implemented to address the root causes of patchy coatings. This could involve:
 - Installation of voltage regulators to stabilize power supply.
 - Implementing preventive maintenance schedules for oil-based heaters.
 - Adjusting coating viscosity control procedures.
- **Standardization:** Standardized Operating Procedures (SOPs) will be developed for the C&S machine operation. These SOPs will include clear instructions for all process steps, quality control checks, and identification methods for patchy coatings and joints.

6. Control

- **Control Plan Development:** A comprehensive control plan will be created to ensure the ongoing effectiveness of the implemented improvements. This plan will outline:
 - Monitoring procedures for CTQs.
 - Data collection and analysis methods for defect trends.
 - Corrective action protocols for identified deviations.
 - Employee training on the SOPs and control procedures.

7. Transition

- **Training and Communication:** The C&S machine operators will be thoroughly trained on the newly designed process, SOPs, and control procedures. This training will encompass both theoretical knowledge and practical application of the techniques for identifying patchy coatings and joints using the chosen method (e.g., color marking pens). Refresher training will be provided periodically to ensure ongoing adherence to the standards.
- **Accountability:** A clear system of accountability will be established. This could involve implementing a system where operators record the number of identified defects on a production log. Exceeding a pre-defined defect threshold would trigger an investigation to identify the root cause and implement corrective actions. Additionally, performance metrics based on the CTQs can be incorporated into operator performance reviews.

8. Benefits and Outcomes

Implementing the DFSS approach at Stellar Packaging Solutions is expected to yield significant benefits:

- **Reduced Defect Rates:** The focus on root cause analysis and targeted solutions will minimize the occurrence of patchy coatings. Standardized identification methods will ensure consistent detection of joints, eliminating the risk of undetected defects reaching the printing stage.
- **Enhanced Process Efficiency:** Streamlined procedures and operator training will lead to smoother production flow and reduced waste due to defective reels. This translates to increased production capacity and cost savings.
- **Improved Customer Satisfaction:** Consistent high-quality coated reels will minimize printing errors and ensure the delivery of defect-free final products to Stellar's customers.
- **Data-Driven Decision Making:** The control plan will establish a framework for ongoing data collection and analysis. This data can be used to continuously monitor process performance, identify areas for further improvement, and make informed decisions about future process modifications.

Conclusion

The implementation of Six Sigma's DFSS methodology at Stellar Packaging Solutions presents a comprehensive approach to addressing the challenges associated with patchy coatings and unidentified reel joints. By establishing a documented process, implementing standardized defect identification methods, and focusing on root cause analysis, Stellar can significantly improve the quality of its coated reels, enhance process efficiency, and ultimately achieve greater customer satisfaction. The ongoing monitoring and control plan will ensure the sustainability of these improvements, paving the way for a more robust and efficient C&S operation.