Molding Scrap Reduction and Reutilization

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Abstract *— A company named ABB, whose operations in Puerto Rico focuses on molded cable installation products, experienced scrap generation during the subassembly processes. The scrap costs represented over $200K per year. The Plant management established an objective of reducing the scrap costs by 50% and the virgin material usage by 15%. Lean Six Sigma Methodologies were used to implement a solution to capture the scrap and reutilize it in the molding process, resulting in cost avoidance of $200K per year and reduced virgin material usage by 15%.*

Key Terms *— Effects of Granulation in Molding Process, Injection Molding, Lean Six Sigma, Plastics Engineering*

INTRODUCTION

ABB is a Swedish company founded in the late 1980s by merging two European powerhouses in the electrical industry. These were Asea and Brown Boveri. Their expertise in motors, transformers, and electrical transmission since the late 1800s helped innovate in the automation and robotic industry since the 1980s, leading the way in mechanical, industrial innovations. ABB has dominated the European market and decided to expand to the American market. With this strategy, ABB operates in Puerto Rico, serving the food, automotive, electrical, and military industries, just to mention a few.

In the Puerto Rico operations, there are molding and subassembly processes. After the molding process, the subassembly generated a scrap rate of at least 4%, translating to over $200K in scrap costs per year. The plant management presented this challenge to the engineering team with the primary objective of reducing the scrap costs by 50% and the use of virgin material by 15%. This paper discusses the condition before the improvements were made, the methodology used to design and implement the proposed solution, and the results driven by the solution.

ANALYSIS APPROACH

In ABB, the philosophy that drives continuous improvement is the Lean Six Sigma philosophy. Based on the philosophy, the approach practiced within this project was the DMAIC methodology.

Lean Six Sigma Methodology

DMAIC is an ordered sequence of project phases where the project manager carries specific actions to objectively document tasks that ultimately solve a problem. These phases are Define, Measure, Analyze, Improve, and Control.

In the Define phase, the problem statement was clearly generated, the stakeholders were identified, and the project team was assembled with specific roles assigned. In the Measure phase, the current state of the process was evaluated and documented to establish a baseline. In the Analyze phase, the data collected from the Measure phase was used to identify critical variables and determine the root cause of the problem. In the Improve phase, designed experiments were used to find the optimal solutions based on the essential variables found in the Analyze phase. In the Control phase, the proposed solution was implemented, and the outputs were optimized by implementing a control plan.

In the Define phase for the project, the problem statement was defined as follows: Since new assembly machines were introduced in the late 1990s in the Puerto Rico Plant, the scrap rate is at least 4% in our most expensive resin, translating to $205K in yearly scrap costs.

The project's scope was to implement a solution that captured the scrap generated and re-utilized it in the molding process as regrind to avoid scrap costs and reduce the virgin material usage.

Process capabilities and baselines determination

In the Measure phase, the goal was to understand the process and document the actual state of the process before the improvements. Based on the project's scope, the material handler measured the process material usage by recording the amount of virgin material used in the molding stage and the amount of scrap generated in the sub-assembly stage, both measured in pounds. The data was recorded at the end of the first and second shifts for 17 days. The molding process was stable through the duration of the data collection process, running within validated parameters and cycle time.

As part of the Analyze phase, a material usage was plotted, and a baseline was created, as seen in Figure 1. Based on the recorded data, the scrap rate was an average of 30%, with an average daily virgin material usage of 265 lbs.

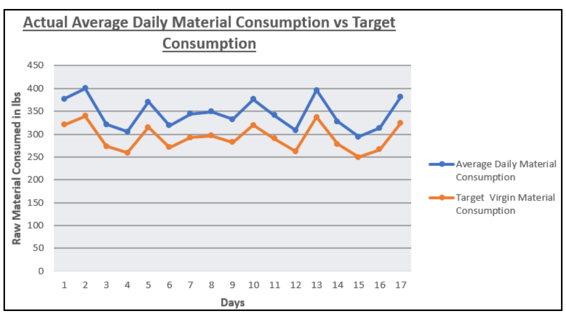

Figure 1
Virgin Material Usage Run Chart

Scrap Recovery methods and solutions

As part of the Improve phase, a solution was implemented to recover the scrap. The Pugh matrix was used in order to select the optimal design solution based on the operations requirements, as seen in Table 1, the sprocket design was the winner. The Pugh matrix utilization was a pivotal, decision making tool in order to determine the best solution to our problem. After selection of the design, an FMEA was also created to anticipate failure modes that could disrupt the subassembly process. In order to recover all the scrap that is generated, the machine was attached to the subassembly machine and synchronized so that all the scrap would be recovered.

Table 1
Scrap Recovery Design Pugh Matrix

Pugh Matrix

Expectations	0	1	2	3	4	5
Easy to Manufacture	DATUM	-	s	+		
Not space consuming		-	-	+		
Cost effective		-	+	+		
Maintenance intensive		s	-	s		
Adjustability		+	-	+		
Complexity		-	s	+		
Total +'s (better than datum)		1	1	5	0	0
Total -'s (worse than datum)		4	3	0	0	0
Total S's (same as datum)		1	2	1	0	0
Comparison						

Concept Summary	
0	DATUM
1	Robot integrated
2	Indexed Carrusel
3	Sprocket based design
4	
5	

RESULTS AND DISCUSSION

As seen in Figure 2, the material usage was extrapolated annually to 96,725 lbs. The project objective was to reduce the virgin material consumption by 15%, which financially translates to $101K. Even though the virgin material is reduced, the use of regrind will compensate for the material usage. A process monitoring system was implemented to control the regrind lot and the blended percentage.

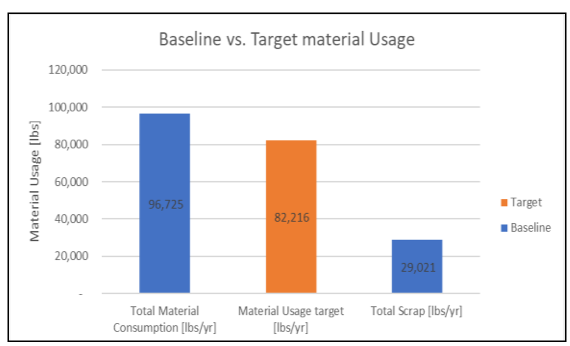

Figure 2
Material Usage Analysis

The use of regrind was limited because the excessive use will yield a negative effect on the product performance if the regrind is processed more than one time [1]. The approved limit of regrind was up to 15%, as approved by regulating agencies. Even though this regulation was limiting, the use of regrind, consequently dampening the financial benefits, it did not affect the improvements made in virgin material consumption.

The cost of scrap based on the agreed purchase of $7/lb was $205K, exceeding the target savings of $105K. Since the project's scope was to recover the scrap, it was used entirely and was incorporated into the molding processes, the regrind implementation is limited to a 15%, the scrap cost is avoided, and the virgin material usage is reduced by 15%.

CONCLUSIONS

Using the Lean Six Sigma philosophy with the DMAIC methodology, a solution was designed to successfully reduce the virgin material consumption by 15% and avoid $205K in scrap costs. The Lean Six Sigma philosophy for continuous improvement projects proved beneficial as a project manager because it provided a logical, objective structure in the methodology that enabled scientific problem solving techniques. The results are a testimony of the success of the philosophy.

REFERENCES

[1] Badia, J. D., et al. "The Role of Crystalline, Mobile Amorphous and Rigid Amorphous Fractions in the Performance of Recycled Poly (Ethylene Terephthalate) (PET)." Polymer Degradation and Stability, vol. 97, no. 1, 1 Jan. 2012, pp. 98–107.