Putting DMAIC of Six Sigma in Practice

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Abstract:

This study concerns a manufacturer that used the Six Sigma process to better control the process of introducing change to its production lines. The company struggled with implementing design and process changes, which led to quality and cost issues and line down-time. A team was created to investigate design changes implemented in the previous year that caused significant issues when they were put into production, such as parts fitting improperly, reworking that was required due to incorrect/incomplete designs, and expediting acquisition of parts because orders to suppliers were delinquent. The team reviewed all of the major design changes implemented in the past year to determine if there were large issues with implementing them. Five projects were identified as having significant problems and the Six Sigma DMAIC process was selected to find the gaps in existing processes and to determine how to best correct them and implement changes for the future.

Keywords: Six Sigma, DMAIC process, implementing new design, increasing communications, improving awareness, training employees

1. Introduction

A large equipment manufacturer used the Six Sigma process to help better control its process of introducing change to its production lines. The company struggled with implementing design and process changes – leading to quality and cost issues, as well as line down-time. A team within the production office was created to investigate the design changes implemented in the past year that had significant issues when they were put into production, whether it be parts fitting properly, rework due to incorrect or incomplete designs or expediting of parts due to delinquent orders to suppliers. The team was led by an assembly engineer who dealt directly with the assembly line in implementing design changes. The rest of the team included a cross-functional mix of design engineers, assembly engineers, supply managers, quality engineers, Spec analysts (those responsible for producing a machine bill of materials, which drives parts presentation to the assembly line) and assembly line workers. This team brought together expertise from all the elements of the company that are needed to implement design changes.

All of the major design changes that were implemented in the past year were reviewed to determine if there were any issues with implementation. Of these, five projects were identified as having significant problems and were the ones that were focused upon. The Six Sigma DMAIC (Define, Measure, Analyze, Implement, and Control) process was used to find shortcomings in the existing processes, determine how to best correct them and implement changes for the future. DMAIC was used because it mainly focuses on making improvements to current issues that are defined based on the voice of the customer and the items that are critical to quality. In other words, DMAIC was chosen since the processes are not meeting customer expectations – for both internal and external customers.

2. Define

This is simply defining the project goals and customer (internal and external) deliverables. The charter for this Six Sigma project revolved around the smooth implementation of running design changes on the assembly line without interruption. Implementation of five specific design changes had led to significant efforts in expediting, redesign, parts rework, and increased product quality. The limited resources of the Company were spent correcting issues that could have been prevented with more initial project planning and activity. The Six Sigma project addressed the root cause(s) in the Company's change management process that lead to line issues. The project deliverable was to make recommendations and put into practice changes to the process of implementing running changes on the assembly line.

3. Measure

This measures the process to determine current performance. A process map scatter plot was created to determine where the root cause of the problem occurred in the process.

This gave the parties involved a visual portrayal of the root cause patterns. The process map identified seven main areas where breakdowns in the processes occurred. The first breakdown was failure to follow the established critical path of the program or project, supplier capability studies not required on the QID (Quality in Design), or QIDs with bad data integrity. QID is a process that has a defined path for each project and steps that must be taken to ensure that the entire project meets specific guidelines and milestones. It occurs at project initiation. The second group of failures occurred between design development and EBuild. EBuild, or electronic build, is a method of virtually building a machine or component using 3-D modeling software so the design can be viewed and manipulated on a computer instead of building physical models. It is used to identify part interferences, awkward assembly positions, and parts that will simply not fit, and to develop special tools needed to assemble the product. It is intended to be the final step before building prototypes of any design. Where non-conformances found during the Company's EBuild were not entered, time and cost constrained the Company from fitting parts up on all physical models and assembly risks were taken.

The third area of breakdown that was identified occurred around the concept, test and analysis portion of the process map, where test requirements were not correctly identified or were not representative of actual field application. The fourth breakdown area occurred at the "complete design" area of the map; not having a completed design but going ahead with production plans, having incomplete prints, and turnover in engineering which essentially "lost" portions of the project.The fifth breakdown area that was discovered was not reviewing QIDs once the project was close to implementation. The sixth area of breakdown was not reviewing the upcoming changes on a weekly basis so that all affected parties were aware of the upcoming changes.

3. Analyze

The analysis portion of this Six Sigma project is simply to analyze and determine the root cause(s) of the defects. This tool helped to identify the cumulative impact of the breakdowns in the five design changes that had major issues at implementation. The metrics used were the actual numbers the team members were able to associate with each breakdown. Within the five design changes, there were 33 total change notices used to implement the projects. Each project should have one, and each additional change notice signifies major issues that were identified and had to be corrected. There were 105 delinquent QID items and an average of 23.4 days lost for QID delinquencies. QID delinquencies ranged from getting initial sample inspection reports from parts vendors, having updated assembly drawings and having parts measured to be sure they were to tolerance. There were 21 total project champions for the design changes (one for each would be normal). A total cost of about a quarter of million dollars was incurred to fix problems with implementation, scrap, expediting parts and excess engineering time. These costs were used as the validation for the project, as there was solid data attached to them.

Considering the goal of the analysis portion of the Six Sigma project which was to categorize the root causes of the breakdown, the team found that process understanding (or rather, misunderstanding) was the most prevalent cause of problems. The Company's workers simply did not understand the processes the Company had in place to implement change on the assembly lines. Another prevalent issue was misunderstanding of the current change tools the Company used, and a third was the general lack of communication between teams in nearly every project. Still another problem was that the critical path was not followed, identified, or updated to reflect changes in the process' scope, adding significantly to the critical path lead times. The final issue was engineer interface and knowledge transfer – the Company was experiencing too many job changes and turnovers.

4. Implement

The implementation stage of Six Sigma is simply to improve the process by eliminating defects. In this stage, the team looked to see what was needed to avoid these breakdowns in the future, and found that training was the "bottom line." The team developed a new training program that every new employee of the group will undergo, as well as yearly refresher training for everyone involved in the change management processes. This training is now mandatory, and is supported by management based on the analysis completed during this Six Sigma project. The first part of the training revolves around understanding the tools that are currently used in change management. One of these tools is Quality in Design training. A second is NCCA (non-conformance, corrective action) training. NCCAs are a way of documenting issues that are found anywhere in production, from parts not fitting, to appearance issues, parts that are out of print or stock and even assembly ergonomic issues. NCCAs must be issued for *every* issue that is found, whether in prototype or production builds.

All employees were recently trained on the new product data management software as well. This software has much more cross-functional interaction with design changes than previous systems, which will lead to better visibility of upcoming changes.

Additionally, the team developed and implemented new training which covers the overall process, from the need for change and a design concept, all the way to production. A new critical path calculator was created and implemented specifically to address the steps used in this company's change management processes and to address close observation of project critical path(s) by management to watch for any scope creep. If there is scope creep, the critical path is reevaluated and adjustments are made. This was not always done in the past. Milestone dates for projects are now driven off of the critical path for every project, rather than allowing some to fall into production schedules. More job overlap and training time has been put in place, so that when job changes happen, new people can get up to speed quickly, with little loss of knowledge transfer. The last part to be implemented was a new communication plan for employees working with the production line. Weekly meetings are held to go over upcoming changes, as well as larger projects that are further down the road. Management routinely reviews these projects, and helps determine which projects need to be discussed weekly and which can be gone over when updates are needed.

5. Control

Since this part controls future process performance, it is considered the most important part of this Six Sigma project. Control stage of Six Sigma is being able to sustain the processes the team has worked to refine. The two main processes that were implemented to ensure sustainability were training and process control. All employees must now be trained on the systems that the Company uses to an acceptable level of understanding, and the processes must be followed. Management must coordinate with instructors to ensure training of new employees. They must take ownership of the employee training matrix and ensure that employees are trained appropriately. Completion of a project scope matrix will now be required prior to the start of any project. This will help define the critical path and define what QID items will need to be completed before a project is implemented. Design engineers will now be required to meet with the leadership team on a regular basis to review the project tracking matrix, and will need to seek leadership approval of project continuation at defined project gates and milestones.

6. Summary

The objective of this project was to increase awareness and understanding of current tools and the change process, and increase communication between all interfaces during project implementation. The implementation with the staff involvement added the most value to design and process changes, and consequently had the greatest impact on quality and cost issues. The key result of using Six Sigma in this application was a major reduction in problems implementing new designs because employees have received proper training, and all of the quality tools are being used to ensure that all of the steps in the design process were followed. Key outputs were reduced costs in scrapped parts, reduced rework costs, greatly reduced engineering time spent trying to fix problems, and better overall quality output from the factory. An additional objective of this project was to generate an easy-to-use tool that defines project scope and critical paths as they align with the QID process. Furthermore, structuring and monitoring of the culture change is a process that will develop only if continued improvements are implemented and sustained. Sustainability of this project will require leadership's total commitment and approval. Finally, the success of this and similar projects depends on all employees working together, with the full support of leadership.