Critical to Quality Process: Faster Improvements at SI Corporation

Employees at SI Corporation have been dedicated to lean manufacturing for years, improving flow and driving out waste throughout the organization. Still, we had nagging issues of scrap, off-quality, and customer service. We were trained in the Six Sigma DMAIC (Define, Measure, Analyze, Improve, and Control) philosophy, but projects dragged on as they competed for line time with kaizen (continuous incremental improvement) events. We found a solution by creating a new program called the Critical to Quality (CTQ) Process. It folds the Six Sigma tools and methodology into the lean manufacturing process, attacking issues with the traditional DMAIC methodology cascaded throughout the organization in coordinated kaizen events.

SI Corporation was founded in 1967 to manufacture sandbag material for the Vietnam War. In 1969, the company began producing products for the carpet market, and evolved to become the largest U.S.-based manufacturer of polypropylene products, with annual sales at $425+ million. Four business units — SI Concrete Systems, SI Flooring Systems, SI Geosolutions, and SI Performance Technology — produce several thousand products in the flooring, construction material, soil stabilization, filtration, automotive, agricultural, home furnishings, and environmental markets. SI operates five manufacturing facilities in Georgia, Tennessee, and Idaho and employs over 2100 people.

Facing New Challenges

SI's largest facility in Chickamauga, GA employs roughly 1200 people who primarily weave carpet backing for the large carpet industry of Dalton, GA. When the recession caused a flattening of the carpet business, SI instituted lean manufacturing to eliminate waste and reduce product costs.

Going lean yielded fast results. SI already had a strong culture of change: opening financial statements to all employees, delineating expectations, and empowering employees to think and act as owners. Lean manufacturing gives employees new tools to remove waste and improve processes, focused on creating value in continuous flow as pulled by the customer.[1] Reduction in non-value-added (NVA) steps was accompanied by a reduction in WIP inventory, in turn spotlighting weaknesses in off-quality, scrap, and downtime. Challenges included product characteristics lacking reliable measurement systems, process parameters not controlled to prevent nonconforming material, and customer needs not properly translated into product specifications. More rigorous analytical methods were needed.

Our regularly-scheduled kaizen events targeted NVA elimination. The kaizen event features three weeks of preparation, an event week of dedicated full-time resources, and three follow-up weeks to maintain the event gains. Traditional techniques ranged from value stream analysis, 5S, standard work, pull, and visual management to Total Productive Maintenance (TPM), Kanban, and poke-yoke (mistake-proofing).

Still facing challenges from scrap and chronic defects, SI turned to Six Sigma. Our Six Sigma project teams focus on variability and defect reduction, assisted by Green Belts and Black Belts trained internally in statistical tools and project management. They use a five-stage DMAIC format: 1) Define — Identify the customer and CTQ characteristics, a specific defect, and improvement goals; 2) Measure — Develop process measures (Ys), evaluate measurement systems, and document process capability and stability, also mapping the process and identifying process inputs (Xs); 3) Analyze — Use tools such as cause and effect diagrams and Failure Mode and Effects Analysis (FMEA) to identify potentially critical inputs, verifying these inputs with statistical tests and graphical tools; 4) Improve — Generate test solutions through optimal settings (frequently determined through designed experiments) of critical inputs; and 5) Control — Institutionalize the improvements through mistake-proofing, control plans, and SPC.

Six Sigma projects proved useful for solving the issues of scrap, off-quality and complaints, but the duration of the projects conflicted with the pace of our lean transformation. With readily available resources, a Six Sigma project takes at least four months.

The CTQ Process

We decided to exploit the combined strengths of lean and Six Sigma for faster, enhanced improvement results. The CTQ cornerstone is the use of a few simple Six Sigma tools within the structure of kaizen, enabling a diverse group of operational personnel to understand and use the required skill set.

Each project team charter's scope includes one product line in one manufacturing functional area, while targeting no more than three product characteristics and three process points (critical to successful execution and results). Rapid project completion builds momentum for change. Each critical process point relates to numerous product characteristics, affecting relative process and product lines. Projects are executed through two consecutive kaizen events. The first is dedicated to analysis and validation; the second implements improvement and control.

Our project teams rapidly progress through the DMAIC process using an eight-step formula:

1. *Define what is important to the customer* after compiling customer issues and disposition history.
2. *Quantify product CTQs* and develop measurements and tolerances to later define the critical relationships between that characteristic and critical process points.
3. *Map the process and identify all process measurements.*
4. *Identify process CTQs* using tools such as FMEA, fishbone diagrams, and affinity diagrams.
5. *Measure current performance.* Validate hypotheses and lay the foundation for establishment of boundaries in Step Six.
6. *Validate process CTQs.* Use designed experiments and statistical tests. Limiting the experiments to simple factorial designs and basic statistical tools as correlation and contingency tables, new participants can produce dramatic results with little technical guidance. Kaizen event one ends at the completion of Step Six.
7. *Improve.* After spending a few hours in preparation, team two can rapidly develop the means for improving the validated process CTQs (reducing variation and detecting potential failures in these critical process steps through mistake-proofing).
8. *Control* (significantly affected by the degree to which the CTQs were mistake-proofed) using simple control plan and standard work revisions to ensure sustained improvements.

At our Chickamauga facility, three CTQ kaizen events per month were conducted in the first six months of our lean/Six Sigma commitment. During each event's preparation cycle, team participants devoted two hours per week to training and data compilation.

Participants came from all levels and departments of the company, including the company's president and vice president of operations. Improvements touched far more than the targeted process points, spurring variation reduction in critical process temperatures, tensions, material paths, and motion ranges. These key process functions — or similar process functions — were repeated throughout most of the manufacturing equipment. As a result, over the past year the facility has cut waste and off-quality generation 35 percent, reduced external defect quantities 50 percent, and improved productivity 30 percent in bottleneck areas. More importantly, our culture has changed. Our engaged work force gained renewed enthusiasm for improvement. Operators and technicians analyze situations, more thoroughly and permanently mistake-proofing the issues.

Melding lean manufacturing and Six Sigma, the CTQ process adds structure and speed to a Six Sigma program's improvement as well as needed analytical tools to lean programs. It provides a high degree of visibility to quality, customer requirements, critical process points, and the importance of variation reduction, helping us to vastly improve organizational performance.

Footnote

1. Womack, James P. and Daniel T. Jones, *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*, Simon & Schuster, 1996.

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