Six Sigma in Action

By Charlie Carpenter

Background

Owens-Illinois Glass Container Division, one of the worlds leading producers of glass containers for the food and beverage industries, wanted to re-define what "world class" meant in their industry. The senior management team had a goal to make their production processes more predictable, efficient, and cost effective. The prescription to achieve their goals was to apply the Six Sigma DMAIC process with a "tiger team" of the best personnel from R&D, Product Design, Glass Technology, and Manufacturing Operations comprised of both salaried and union employees. The improvement opportunity was estimated at $125 Million dollars annually.

The Challenge

Faced with customer complaints and warranty issues the team had to identify where to focus their efforts to achieve significant breakthroughs in production process improvement. The initial wave of the Six Sigma DMAIC process was targeted to tackle 4 to 5 focused projects. The timeframe for this first group of projects was 3 to 6 months. Process Predictability Management, Inc taught and facilitated the "tiger team" through the Six Sigma DMAIC process, comprised of the following phases

1. Define
2. Measure
3. Analyze
4. Improve
5. Control

Complexities of the Production Environment

- Four different production processes
  - 41
  - 62
  - BB
  - NNPB
- 22 factories in all regions of the US
- Food Industry Product examples
  - Baby food jars
  - Pickle jars
  - Ketchup bottles
- Beverage Industry Product examples
  - Beer bottles
  - Wine bottles

  - Tea bottles
  - Liquor bottles
- Customer examples
  - Gerber
  - Heinz
  - Miller
  - A-B
  - Seagram
  - Mondavi
  - Coca Cola

This case study focuses on only one of the initial wave of five projects.

The Solution

Following the 5 phases of Six Sigma the team embarked on their mission.

- Define
  - In this first phase the projects purpose and scope are defined as well as the initial pass at a business case. Process and Customer information is collected to identify how well the process is meeting customer requirements.
    - A customer survey was conducted to identify customer needs which could then be translated in CTQs (Critical to Quality characteristics)
    - Customer Warranty and Complaint data were reviewed
    - Factory defect histories were reviewed
    - This data was then ranked and prioritized as the “What” axis in a QFD Matrix (quality function deployment)
    - Production process maps were completed for the 4 major processes making glass containers
    - Five projects were identified and commissioned during this first phase
    - This case study focuses on the Long Neck Beer Bottle Project from the NNPB process with an initial business case savings estimate of $5 million.
- Measure
  - The goals of the Measure phase are to establish baseline process performance, narrow the focus of the project scope and problem statement, and increase the accuracy of the business case. The following is baseline measures for the Long Neck Beer Bottle Project.
    - Dimensional variance on volume was causing ATF tax warranty issues from the brewery
    - Excessive breakage during brewery processes
    - Container weight = 6.5 oz of glass

- Production rate = 520 bottles per minute per NNPB process
- Annual production volume NNPB process = 256 Million bottles
- Process yield = 94%
- Annual losses = $500k per NNPB process

- Analyze
  - The goals of the Analyze phase are to identify potential root causes of process issues that directly effect critical to quality customer requirements. Theories are tested and validated with data. The output from this phase is verified causes that lead to solution development in the next phase.
    - Conducted a QFD analysis of the relationships between process variables and CTQs
    - Analyzed approximately 4000 relationships in the QFD
    - Narrowed the focus to
      - Glass composition
      - Machine control
      - Mold equipment design
    - Conducted Designed Experiments (DOE) to verify the root causes
    - Identified new operating windows for processing parameters
- Improve
  - The goals of the Improve phase are to develop and pilot proposed solutions, validate that they address the root causes of the process issues, and achieve or exceed the expected benefits. Once validated, plans are developed for full-scale implementation of solutions.
    - Designed new mold equipment
    - Designed a new glass composition
    - Validated machine operating windows
    - Conducted a multistage DOE to pilot the solutions and determine overall optimal operating parameters
    - Planned the rollout to the other 9 NNPB processes in the other factories
- Control
  - The goals of the Control phase are to evaluate the new process performance and compare it to the baseline. The business case is updated with the quantified benefits and booked by finance. Standards, documentation, and training in the new process are completed. Process controls are institutionalized to maintain the gains and identify further opportunities for continued improvement.
    - Defined SOPs, documented them, and conducted training
    - Implemented Statistical Process Control (SPC) on the NNPB process operating windows
    - Quantified the new process performance

- Updated the business case
- Project was completed in 12 weeks
- Began the rollout implementation process on the other 9 NNPB processes (completed in 6 weeks after new mold equipment was manufactured)

The Results

Full implementation on a single machine and furnace combination resulted in

- **Material Savings of $300k per year per machine and furnace**
- **Fuel Savings of $560k per year per furnace**
- **Total Savings across all 10 NNPB Processes = $8.6 Million**
- **Major Brewer awards OI additional 25% of their bottle business**
- **Timeframe to Complete this Project on One Machine = 12 weeks**

- **Before the project**
  - Container weight = 6.5 oz of glass
  - Production rate = 520 bottles per minute
  - Annual production volume per NNPB process = 256 Million bottles
  - Process yield = 94%
  - Initial business case projected a $5 Million potential for savings
- **After the Six Sigma DMAIC project**
  - Container weight = 5.8 oz of glass
  - Production rate = 560 bottles per minute
  - Annual production volume per NNPB process = 276 Million bottles
  - Process yield = 96% (theoretical maximum given process control requirements and all samples are recycled into furnace)
  - Dimension Volume Integrity = improved averages and dramatic reductions in variation (constant fill level for the breweries)
  - Breakage issues virtually eliminated
  - Material usage savings = 5,600 tons of glass per year NNPB process
  - Final business case savings = $8.6 Million

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