Uniworld Consulting, Inc.

Six Sigma Lean

Automotive Bushings

Automotive Supplier: Multi-cavity Mould Variation Reduction

Summary

- Development program to design and produce suspension bushings for a new prestige vehicle
- Designed for production on a multi-cavity mould
- Project Problem:
  - unable to meet required capability on a key dimension prior to launch
  - Inefficient process:
    - excess inspection
    - scrap and rework
  - Firm in jeopardy of losing the contract and any potential future business

Key Tools Applied

Lean DMAIC methodology

- Process Mapping
- Prioritization (Cause and Effect Matrix)
- FMEA
- Measurements Systems Analysis
- Design of experiments

Project Results

Reduced variation of the key dimension by 70%, prior to launch.

The resulting stable and capable process demonstrated the firm's ability to be selected as a strategic supplier, resulting in future business.

Project Background

Customer Requirements

- The car manufacturer specified that processes should have a minimum Cp and Cpk value of 1.667 for all critical characteristics

Initial Capability

- Initial studies revealed that the process was unstable and incapable of meeting the car manufacturer's standard for a key dimension.
- It was noted that a minimum Cp and Cpk of 1.667 was more difficult to achieve than the “6 Sigma” standard of Cp = 2.0, Cpk = 1.5.

Development Strategy

The improvement team took action by studying the problem using The Six Sigma Lean Process Improvement Roadmap of

- Define
- Measure
- Analyze
- Improve
- Control

Step 1 Define

Problem Statement:

Process is incapable of meeting the customer specified quality standard

Unstable process is producing excessive variation

Project attack plan:

- Reduce the variation
- Re-measure the capability
- Carry out further experimentation (if necessary)
- until the process has Cp and Cpk of 1.667 or greater

Step 2 Measure

- Tools Used:
  - Process Map, Prioritization Matrix, Measurement Systems Analysis and FMEA.
- Resulting Actions:
  - Standardized the loading and unloading sequence of the press
  - Investigated the variation due to the measurement methods
  - Improved Measurement methods
  - Created and prioritized list of candidate variables for the Improve Phase

Step 3 Analyze

Passive Observation Study and initial capability study over 125 runs captured and analyzed variation due to different:

- Operators
- Loading sequences
- Cavities

- The findings were carried through to the Improve Phase.

Step 4 Improve

Variables

- Five variables were considered as most likely to affect the process critical characteristics

DOE Design

- Candidate designs involving 8, 16 or 32 experiments were considered
- Because reducing variation was the primary aim of the project, it was decided :
  - to study the process using a 2^{5-1} half fraction design
  - Each experiment was performed twice across all 6 cavities of the multi-cavity mould.

Step 4 Improve - continued-

Experimentation

- The experiments were carried out in a random order, using normal production equipment
- Dummy experiments (lifts) were inserted between the actual experiments to ensure that an experiment had no “memory” of the previous one
- The logistics of the experimentation were quite complex.

Improve – continued-

Analysis

- The standard DOE Analysis Roadmap was used to calculate coefficients to produce mathematical models and draw Main Effects Plots for visual interpretation
- The use of full replication allowed the analysis of mean and variance to be performed.
- This enabled the effect of the variables on the average value and on the variation in the critical characteristic to be calculated and understood.
- The best set of conditions for minimum variation was selected.

Improve – continued-

Confirmatory Experiments

- The DOE study predicted a reduction of 70% in the variation for this critical dimension. The predicted results versus the “Target Specification” are below.

Target Spec	Before DOE	Predicted from DOE
67.40 ± 1.00 mm	67.23 ± 0.14 mm	67.31 ± 0.04 mm

- A 25-run confirmatory study confirmed the predicted 70% reduction.

Before DOE	After DOE	% Improvement in Variation
Maximum variation 0.326mm	Stable, capable Maximum variation 0.244mm	74% reduction

Control

The controls implemented included:

- SOPs throughout production, storage, testing and packing prior to shipping, as identified from the passive observation study and the FMEA.
- Best set of operating conditions as defined from the 5 variable DOE study
- Better testing methods based on the measurement System Studies

Conclusions

- The production of the suspension bushes was stable and capable, and in volume production for the launch date.
- The benefits of having the expertise to produce stable and capable processes (Cp and Cpk greater than 1.667) were the company:
  - gained a competitive edge in the market place
  - was able to reduce costs by:
    - Reducing inspection
    - Reducing scrap
    - Reducing re-work
    - Improving efficiency
  - protected their existing business by demonstrating their abilities in a high profile project
  - gained the confidence of the customer as a strategic supplier which enabled them to be considered for and able to win future business