Uniworld Consulting, Inc.

Six Sigma Lean

High Volume Equipment Manufacturer

Extrusion and Forming Process

Background

- **Introduction -** The company, based in the UK, produces plastic rails for a vending machine supplier. Sachets of coffee, tea or other beverages are slotted onto these plastic rails that are then positioned inside the machines. In normal use the sachets would slide freely along the rails and be used to provide the vendor with the required drink.

Background

- **Problem -** It is essential that the slot width of these rails is constant to avoid the sachets either getting jammed on the rails or alternatively falling off them. Unfortunately the variability in slot width reached such a high level that the customer lost confidence and rejected an entire seven weeks production amounting to some 700,000 rails. Although it was shown that a large proportion of these rails were in fact satisfactory, manual inspection was not feasible and the vending machine supplier stated that they intended to take their business elsewhere if the slot width could not be held to the required tolerances.

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

Key Tools Applied

Lean DMAIC methodology

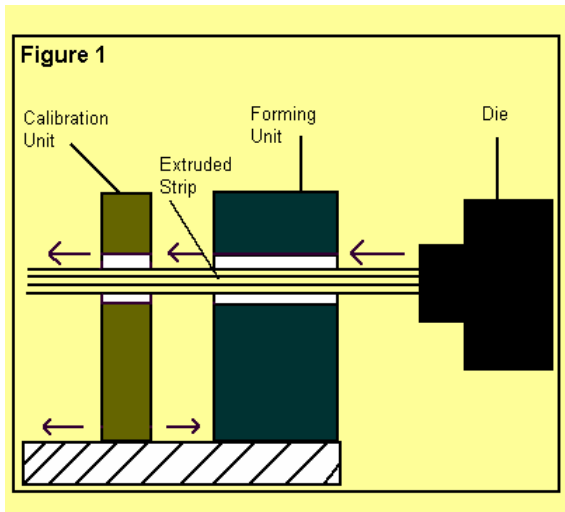
– Process Mapping
– Prioritization (Cause and Effect Matrix)
– FMEA
– Measurements Systems Analysis
– Design of experiments *
– Control Plan *

* Described in this case study

Process

1. “Die” extrusion of hot plastic forms a continuous strip rail with a U-shaped cross-section
2. A "Forming Unit" cools the strip and gives it some stability
3. A "Calibration Unit" fine tunes the strip to the required dimensions
   a. Slot width of 7.6mm +/- 0.2mm
4. Strips are cut into 340 mm lengths, marked and notched

An air bubble tends to form inside the plastic prior to the calibration unit. Does this air bubble have any effect on the dimensions of the strip. Figure 1 is a schematic diagram of the process.



Improve

- Figure 2 shows the DOE that was used to study the effects of changing the four variables.

Figure 2

Experimental Variables

Extrusion Rate	32	35
Die Temperature	145	155
Calib. Unit Position	1	2
Bubble Present	Yes	No

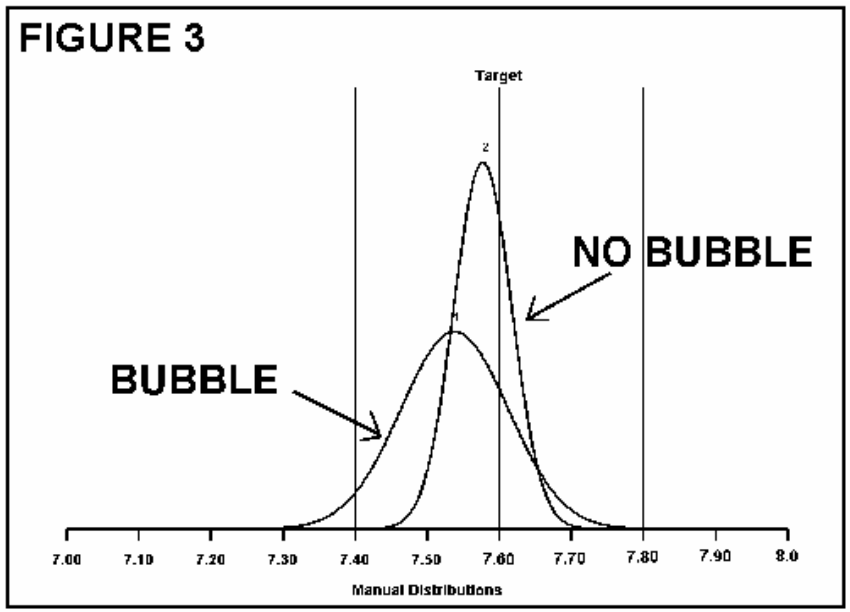
Improve

DOE:

- A number of rails were produced for each experiment; the mean and standard deviation were calculated for the slot widte
- Results:
  - Ensure the extrusion rate is set at 3
  - Die temperature should not fall below 155 C
  - Calibration unit position should be about half way between the two positions studied in the experiments.

Improve

- The most striking conclusion was that the presence of the air bubble had a most adverse effect on slot width. The difference in slot width distribution produced by allowing the air bubble to form is clearly shown in Figure 3.



Control

The controls implemented included:

- SOPs based on the FMEA and Design of Experiments results
- Best set of operating conditions as defined from the DOE

Conclusions

- Initially vending rails were commonly produced with slot widths that ranged from 7.2mm to 8.0mm, but after the Six-sigma project the slot width has consistently been 7.6mm with a variation of 0.1mm or less.
- The customer now has renewed confidence in the supplier and since the implementation of the project's findings, has not rejected a single rail.
- The supplier is presently considering doubling their production capacity for vending machine rails to accommodate the increased demand that they are experiencing.
  - Reduced variation of key dimension by 75%