V.1 December 2015


# Case Study

## Enhancing customer satisfaction through product improvement

- Oman-based pipe manufacturer

Learn. Improve. Achieve

# Summary

## Challenge

Omani-based pipe manufacturer needed to improve product quality.

## Root Cause

Burn marks appearing on pipe joints as a result of curing process when pipes were joined together.

## Output

Analyse manufacturing processes to identify root causes; then alter manufacturing procedures to fully eliminate future problems.

## Results

Enhanced customer satisfaction, confidence and support.

Case Study

Lean six sigma

# Enhancing customer satisfaction through product improvement

## Overview

**Our Omani client, a manufacturer of composite pipes, followed lean-six-sigma methodology in order to substantially reduce the number of pipe joint 'burn marks' where two pipes were joined together. By identifying the root cause of the burn mark problem, our client dramatically increased customer satisfaction.**

## Define

- Need to increase customer satisfaction with product.
- Clearly identify source of burn marks affecting product quality.
- Utilise DMAIC framework to analyse problem and identify solution.

With more than 40 years' industry experience (including 10 years in Oman), our client was a leading manufacturer of Glass Fibre Reinforced Plastics (GFRP) systems. They wanted to increase overall customer satisfaction, particularly since several clients had been complaining about burn marks on pipe joints, and were concerned that these marks might affect pipe integrity.

It was thought that these burn marks (located over the pipe socket) occurred during the adhesive curing process, so the project team (comprising field engineers and shore-based staff) undertook a lean-six-sigma project to determine if this was the case. Over a period of fourteen weeks, the team worked through the *Define – Measure – Analyse – Improve - Control (DMAIC)* framework, and in so doing, they identified the root cause of the burn marks. They then addressed the problem, and greatly improved customer satisfaction levels.

## Measure

- Detail CTC and CTP parameters plus process map and brainstorming to determine reasons for fault occurrence.

The team began by detailing the *Critical-To-Customer (CTC)* and *Critical-To-Process* (CTP) parameters. Next, they completed a process map and a brainstorming exercise – and both of these procedures helped the team to determine possible reasons why burn marks might be occurring.

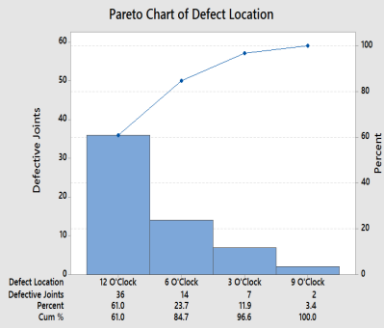
The team knew that if the curing temperature exceeded 190°C, burn marks would appear; they were also aware that the materials passed through the 'Glass Transition Temperature' region (known as 'Tg'), which is defined as the temperature range in which polymers transition from hard, glassy material to a soft, rubbery material. To ensure this phase occurred, a minimum Tg of 120°C needed to be achieved.

learn

## Measure

- Identification of critical temperatures affecting integrity of manufacturing process.
- Collection of relevant data to establish precise patterns of fault occurrence.

To establish the location of burn marks on the piping, the shore-based project team asked the field team to collect relevant data; the results revealed that 61% of the burn marks were observed at the 12 o'clock position. On further investigation, the shore-based team learnt that this was where the heating blanket overlapped when wrapped round the pipe. Pareto analysis showing the position on the pipe where the burn marks were observed




## Analyse

- Identification of probable sources of product damage.
- Establish correct functioning of equipment.
- Subsequent identification of process (not equipment) as cause of product damage.

At this stage in the project, the team now knew that burn marks were typically observed in the same position. Following a brainstorming event, they concluded that this was probably due to one of the following factors:

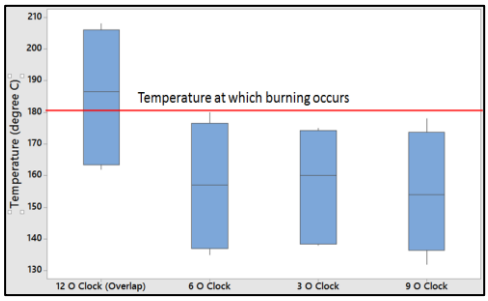
Equipment-related;

- Damage to the heating blanket
- Improper coil arrangement within the heating blanket
- Defects in the particular batch of heating blankets
- Damage to the temperature control device being used
- Heating blanket cut-off valve set incorrectly during manufacture

Process-related;

- Overheating due to heating blanket overlap

By inspecting the equipment and running some calibration tests, the shore-based project team determined that the equipment was functioning correctly. They also concluded that the problem was being created by the process, and that the most likely root cause was overheating, where the heating blanket overlapped when wrapped round the pipe. By measuring the temperature at various positions around the pipe, they could determine with certainty whether 'blanket overlap' was causing excessive heating. At the 12 o'clock position where the heating blanket overlapped itself, the average temperature exceeded 180°C, which was above the specified tolerance and, therefore, a possible cause of burning;



## Improve

- Identify precise cause of process fault.
- Identify defined improvement opportunities.
- Undertake trials of possible solutions.

The team had learnt that burn marks were caused by blanket overlap - and by then looking at the Standard Operating Procedure (SOP), they discovered that the location of the thermocouple was not clearly defined, which was the reason that the increased temperature at the overlap position had not been noticed before; it was also concluded that the variation in temperature range was too high, and needed to be controlled more tightly.

To deal with the root cause(s) of the burn-mark issue, the team generated nine improvement opportunities, which they were able to objectively assess against:

- The effect as measured against Tg
- Joint integrity
- Feasibility
- Ease of implementation.

By scoring each of the nine improvements against these criteria, they could then prioritise the improvement ideas.

They decided to reduce the temperature at the overlap region by placing insulation in this area. To make improvements to the heating blankets, the client and the heating blanket supplier undertook a trial in which heating blankets were fitted with external temperature regulators. In addition, the heating segment of the heating blanket was reduced at the location of the overlap.

## Control

- Execute and analyse final tests.
- Confirm and adopt agreed new processes.
- Revise and update working methodologies.

Before selecting their final improvement strategy, the team tested their various improvement ideas. Identifying the need for new heating blankets with modified heating elements (especially around the overlap areas), they chose an external temperature controller in preference to internal thermocouples, since the external temperature controller offered better control over the temperature range.

It was agreed that the new heating blanket would be used on all new projects – and as a result, the new parts were factored into the material replenishment system, and the part code was uploaded. Finally, to ensure that the lessons learnt would be adopted as standard working procedures from now on, the site bonding procedure was revised and updated.