RCM & DMAIC Improvement Process: Eliminates Expensive CAPEX Improvement / Replacement Requirements, Reduces Process Variability & Rework and Mitigates Risk

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Background

Inherent problems in plant and equipment performance can result in frustration for many engineering managers, especially when it is causing the business significant costs to production. One tool for managers is to build a strong business case for a capital replacement or an improvement project, to eradicate the problem and move on to the next issue. This may be the right thing to do if every other option has been exhausted, but a costly option if the problem has not been fully understood.

The capital replacement route can however be an easy option but a costly alternative certainly in times when capital funds are not readily available. By replacing the problematic equipment with a new design doesn't always get to the root cause of the problem, which invariably has a human or procedural element involved.

The following is an example where the solution being sought was a business case to replace a problematic finishing process which had significant reliability issues, including a perceived over-complicated design and also some parts sourcing issues.

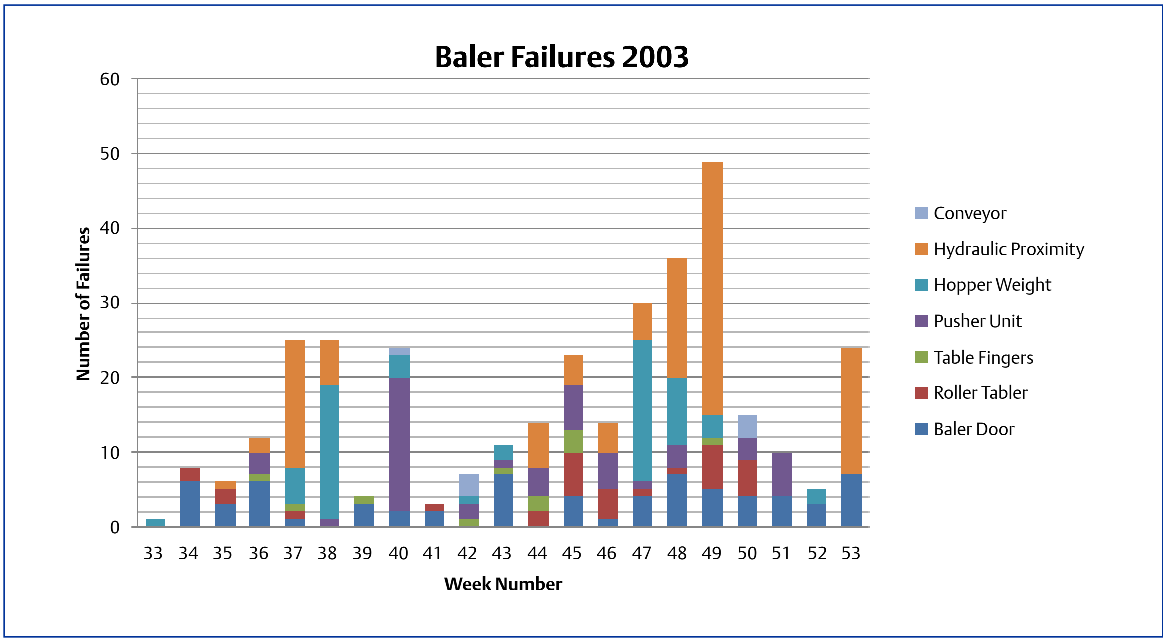
Definition

A steel scrap baling system on a continuous annealing line was causing ~£500,000 per annum in rework costs on final product (diversion of steel coils back to finishing units for final side-trimming, at a rate of approximately 20 coils per week). This was due to the unreliability of the scrap metal baler system. The initial requirement requested by the Engineering Manager was to review scrap baling process and associated issues to build business case for a CAPEX project to replace scrap baling system (initial view was complete redesign was required).

Measure

A failure recording regime was in place, with causes for coil diversions, due to scrap baler and associated sub-system failures being recorded. The analysis during 21 weeks of 2003 is shown below.

From the initial data analysis it was apparent that there were several sub-system reliability issues, causing coil diversions and associated re-working requirements.



Analysis

In order to understand the whole-system issues, it was decided to conduct a reliability review of the scrap baler, using reliability centred maintenance (RCM) methods, in order to understand the problems fully and what the best solution would be for Business.

People investment

- 12 Workshops approx. 2 hour duration
- 2 people per workshop = approx. 48 man hours
- Approx. ½ hour per failure mode

Control and monitoring equipment had been installed on the Baler to ensure safe and reliable operation. However, it became apparent during the RCM Analysis that there were no inspections or procedures in place to ensure that these systems remained in good working order. This was evident in the following examples:

- Filter Sensor Failures
- Hydac Unit Failures
- Proximity Switches

Filter Sensors on Baler Lubrication System

Functional Failure	Failure Mode: Sensor Fails	Failure Effect
Fails to indicate filter condition		Lubrication pumps would trip on current overload. Oil filter would be found to be blocked. Production cost £5000 Spare cost £50 Labour cost £100

Findings from the analysis of the Filter Sensors also uncovered the following:

- Filters changed on a regular basis – not necessarily when needed
- Signals fed back to the PLC but not used
- Sensors never tested – hidden failures

Hydac Unit on Baler Lubrication System

Functional Failure	Failure Mode: Hydac unit Fails	Failure Effect
Fails to control the pressure of the lubrication system. Fails to maintain the lubrication oil at a temperature of between 35 & 50 degrees		System could run with no control – loss of lubrication oil resulting in catastrophic failure Oil temperature would become unregulated, pressure fluctuations should be picked up by pressure monitoring hydac unit

Findings from the analysis also uncovered the following:

- The failure to control the pressure of the lubrication system could lead to a production cost of £650,000
- A failure to control the temperature of the lubrication oil could lead to a production cost of £75,000

NB: Hydac units were failing at a frequency of one per year, at time of analysis.

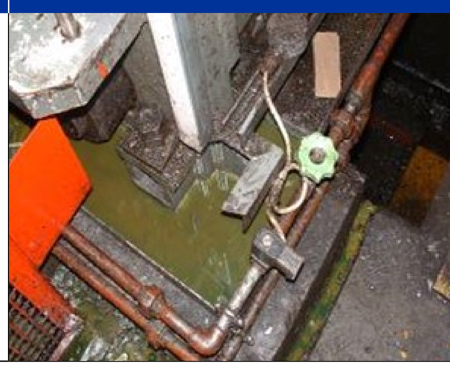
Lubricating Oil Tank Level Proximity Switch Failures

Functional Failure	Failure Mode: Proximity Switch Fails	Failure Effect
Fails to alarm and trip if the lubrication oil drops or exceeds a certain level		Pressure drops in system, baler will drop out of service. In the event of low low level alarm failure, baler will stop: Production cost £72000 Spare cost £38 Proximity switches fail

Findings from the analysis also uncovered the following:

- The proximity switch provided no indication of failure
- The proximity switch formed part of the safety devices on the Baler.

Solenoid Valve on Baler Lubrication System

Functional Failure	Failure Mode: Solenoid Valve Failure	Failure Effect
Fails to distribute lubrication oil to individual headers		Lubrication oil is not directed to the liner plates causing catastrophic failure. Replacement of a full set of liner plates is required – Production cost £650K Labor costs £1.8K Spare cost £70K Has not yet occured

Functional Failure	Failure Mode	Failure Effect
Fails to contain oil within the system	Pipe-work failure between solenoid valve and header	Lubrication oil is not directed to the liner plates causing catastrophic failure. Replacement of a full set of liner plates is required – Production cost £650K Labor costs £1.8K Spare cost £70K

Findings from the analysis also uncovered the following:

- No indication of failure from solenoid valves
- No redundancy in system to pick up failure

Implementation

Revised maintenance and operational procedures developed, together with minor modifications. In addition, increased awareness of the operation and maintenance needs, as a result of the reliability analysis of the scrap baler, resulted in no requirement for CAPEX to replace baler.

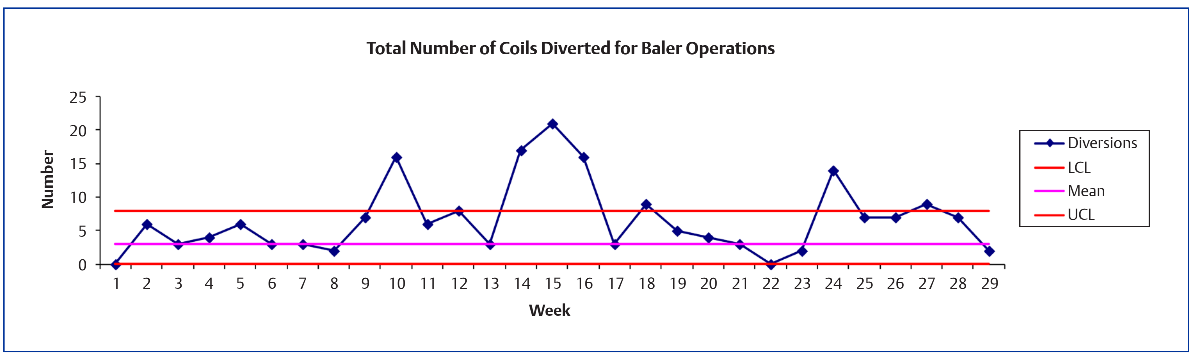
Process Output

- Identified 88 Failure modes
- Analyzed 83 Failure effects
- Creation of 41 PM Jobs
- Creation of 3 new Engineering Standards
- 4 recommended redesigns

Control

Reduced rework requirements from average of 17 coils per week down to average of 6 coils per week within six months of completing analysis and implementing key recommendations. Savings for the Company per annum of ~£375,000 plus CAPEX saving, estimated to have been in excess of £1,500,000, were realised.

Note: Management decision made to divert coils during weeks 14, 15 & 16, during period of high production requirements.



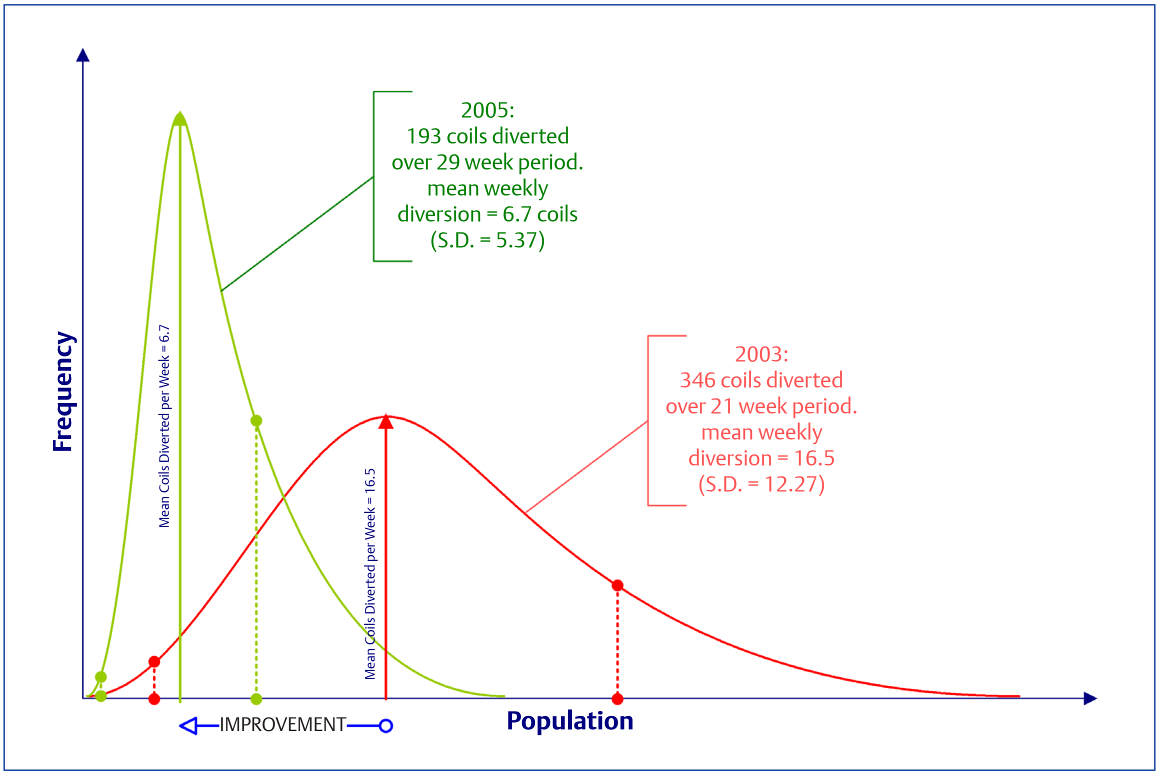
Conclusions

In this case, the need for an expensive capital investment was averted and significant process cost improvements were achieved with little additional costs, other than some simple modifications, which were more than covered by the reduction in re-work cost savings.

In addition to the cost savings, the risks associated with potential hidden failures was far better understood, ensuring that the function and maintenance needs of the protective devices were being managed going forward.

These significant benefits were achieved through a better understanding of the plant and equipment by the personnel responsible for operating and maintaining the plant. In the event that a new baler system had been purchased, then the danger would have been that the same issues of lack of understanding of the new plant could have raised itself over time. Instead, the "learnings" from the Reliability Centred-Maintenance output were documented and implemented into the PM system. It also meant that the satisfaction of resolving the problems, that had dogged the plant for several years previous, was more than apparent by the engineers and technicians responsible, with greater ownership for the asset care activities – and a sense of achievement was borne.

The application of a DMAIC approach coupled with RCM is a powerful combination, especially where there are / may be multiple contributory (reliability) issues. The ability to analyse the whole-system, with RCM, was an essential element in the success of this example – some other analysis techniques would look to resolve specific failures or would not have been able to identify the "Significant X" (in Six Sigma terms), due to the resolution of the data available. That should not detract from the DMAIC concepts which indeed provides a strong model to work to, in order to cut through perception and need for robust data.



Therefore, Reliability Centred Maintenance should not be seen as something that the maintenance and reliability engineers use, but should be embraced as a process improvement technique, in conjunction with DMAIC and other improvement tools.

These improvement techniques working together are in fact business improvement aids – effective and able within the realms of risk-based management and challenging and / or validating capital improvement / replacement decision-making, by unlocking potential hidden capacity and waste within many organisations. These points are extremely significant nowadays, in a world of economic uncertainty and significant competition for capital funding and the need to maximise returns on assets.

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