QUALITY IMPROVEMENT USING POKA-YOKE

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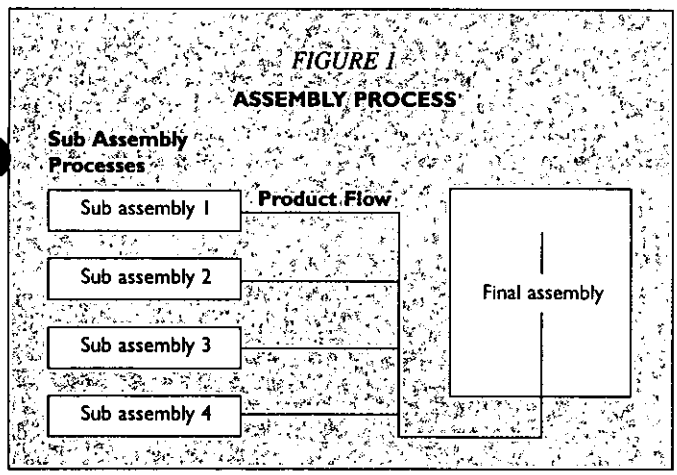
INTRODUCTION

This article discusses how a major manufacturing organisation, introduced and developed poka-yoke with the objective of reducing defects and ultimately improving product quality.

The company is located in South Wales on a greenfield site in which it has invested over £120 million and currently employs around 1,200 people. The plant is highly automated, current output levels being around 13,000 a day and it is accredited to IS09001 and QS9000.

An overview of the manufacturing facility layout is shown in Figure 1.

FIGURE 1



The company has a commitment to continuous improvement, providing training and support to all employees in techniques such as Statistical Process Control (SPC), Single Minute Exchange of Dies (SMED), Total Productive Maintenance (TPM) and Problem Solving Methodologies and Concepts.

A key measure of quality is the number of 'zero-kilometre failures'. A zero-kilometre failure occurs when finished goods fail to operate at the end of the car manufacturer's production line, ie. when the vehicle has done 0-km. This is either because the product sent is faulty or an incorrect product variant has been sent to the customer.

The aim is to reduce zero-kilometre failures to less than 10 ppm (parts per million) from a level of 100 ppm in 1996 which would compare favourably with the current 'Best in Class' quality performance of their main competitors.

WHAT IS POKA-YOKE?

The concept of poka-yoke is not new. The term simply means 'avoiding error' or 'mistake proofing'. The Japanese engineer, Shigeo Shingo has been generally recognised as the foremost proponent of poka-yoke [1].

Shingo defines a poke-yoke device as '..... **an improvement in the form of a jig or fixture that helps achieve 100% acceptable product by preventing the occurrence of defects.**' Poke-yoke devices prevent errors occurring and thus eliminate defects completely or are used as automatic sensing/warning systems which detect defects and prevent them being passed on to the next stage of production or to the external customer.

Chase and Stewart [2] suggest that poka-yoke works best when:

- There is a fixed sequence of operations that are routinely followed. Ideally these should be linked to form an obvious value-added chain of activities.
- Each operation has clearly identifiable goals and specifications. If operation outcomes are unclear, spend time rethinking the operation design rather than mistake-proofing.
- The number and range of inputs to be controlled during each operation is small. While one of the big advantages of poka-yoke is controlling multiple inputs, simple systems are inherently easier to mistake-proof.
- The customer 'knows the drill' in general terms at least. The more familiar the (internal or external) customer is with the process, the less it has to be explained and the fewer the number of contingencies that have to be mistake-proofed.
- Tasks and tangibles rather than treatments are the core features of the service. It is easier to set poke-yokes for action rather than change attitudes.
- The process design must be fundamentally sound. Motivating employees to mistake-proof a rational, well thought out process is a lot easier than motivating them to mistake-proof a poor one.

IMPLEMENTING POKE-YOKE IN PRACTICE

The decision to introduce poka-yoke at the site was taken at senior management level during a meeting in January 1996. At the meeting, the concept of poka-yoke was introduced and discussions were held to plan its implementation.

Initially, a steering group, consisting of the three top managers at the plant, was set up with specific responsibilities for providing the necessary resources and showing top-level commitment to the project.

Second, an implementation team, consisting of seven line managers and a facilitator, was put together to produce a detailed plan for the site introduction of poka-yoke and to identify how and where poka-yoke fitted into the strategy for achieving less than 10 ppm zero kilometre failures.

Before embarking on the launch of the programme, a number of key areas needed to be understood. The first question raised by the group was **'How does the concept of poka-yoke fit into this site's quality philosophy?'** The team set out to answer this question and after much discussion produced specific sitedefinitions for the poka-yoke programme. They embodied these in a three-stage approach illustrated in Figure 2.

FIGURE 2

SITE SPECIFIC DEFINITIONS, POKA-YOKE SYSTEMS

STAGE 1: DESIGN
The design of a part, or the process, is such that a mistake cannot be made

STAGE 2: INPROCESS ERROR PREVENTION AND DETECTION
A prevention/detection device which, during the operation, checks that the operation is done correctly

STAGE 3: DOWNSTREAM DETECTION
An automatic device which checks (100%) for defective parts. This is a consequence of not having Poka-Yoke 1 or 2

The introduction of poka-yoke was specifically linked to the three-stage objectives shown in Figure 2 above. These definitions placed the emphasis on improving the design of

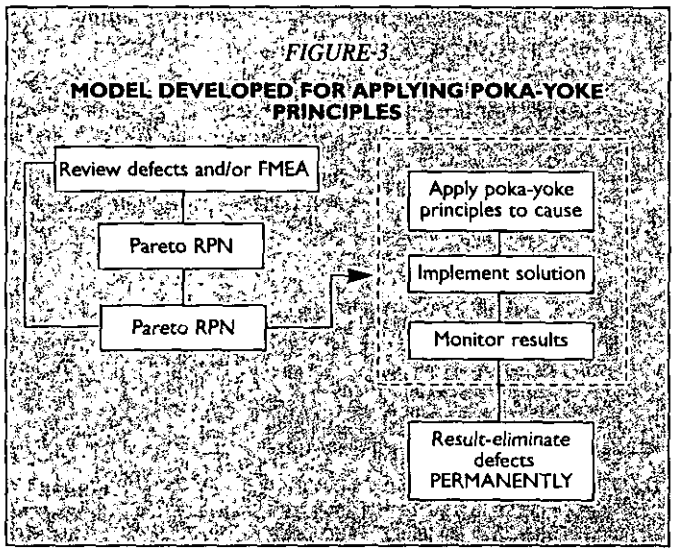
the product and process as a crucial first stage. If this was impracticable, the solution would 'drop down' to a Stage 2 method and if this was not achievable then Stage 3 poke-yoke detection devices would be used. This was a key point in the introduction of poka-yoke at the factory since it clarified the concept of poka-yoke for the team and attempted to focus improvement methods on prevention rather than the detection of defects.

The group then attempted to answer a second question **'What current tools can we use to assist in the implementation process?'**

To clarify the sequence, a model was developed to integrate the introduction of poka-yoke with two techniques that were already in use. Failure Mode and Effect Analysis (FMEA) was used to develop a Risk Priority Number (RPN) and a problem-solving technique (eg 5 why?) was used to determine the 'root cause' of the issue being analysed. The stages of this model are shown in Figure 3.

FIGURE 3

MODEL DEVELOPED FOR APPLYING POKA-YOKE PRINCIPLES



Two further important tasks were identified as being critical to moving poke-yoke forward: the *education and training* of all group leaders and engineers in the theory and application of poka-yoke and the introduction of poka-yoke through *specific pilot projects.*

TRAINING AND EDUCATION

All engineers and line managers were to be trained in the concepts and application of poka-yoke. This was undertaken by site personnel themselves with assistance from Modula (UK) Ltd who had expertise in the theory and application of poka-yoke. A one-day programme was developed by the training provider working closely with the implementation team and the poka-yoke facilitator.

The aim of the programme was to relate poka-yoke to every-day events and objects through the use of individual and team practical exercises. This enabled the participants to practice the ideas and familiarise themselves with opportunities for applying poka-yoke at the factory.

The approach to training and the content of the programme was very successful and the following is a summary of the feedback from the evaluation sheets completed by partici-pants.

- Visible top-down commitment was apparent (Technical Director and Group Leaders) during the presentation and this gave the perception that this initiative was important.
- This type of practical session was deemed to be the most useful part of the course and generated good ideas which should be followed through.
- These practical sessions should be incorporated into all future training (at all levels).
- During practical sessions, 'fresh eyes' from other departments gave advantages when investigating poka-yoke improvements - that is, better able to adopt 'green-field' thinking.
- Implementation teams should be cross-functional and include persons from other areas.
- There is a better chance of cross-fertilisation benefits from mixed teams.
- The use of cross-functional teams increased the awareness of day-to-day problems that arise in other areas.

THE INTRODUCTION OF POKA-YOKE THROUGH SPECIFIC PILOT PROJECTS

The initial pilot programme was applied to each of the production lines. It aimed to introduce the principles of poka-yoke through a structured approach. FMEA was used in conjunction with Pareto analysis to highlight the main opportunities for improvement. The aim was to identify one or two key pilot projects per production line.

The next stage was to develop measures that were specific and relevant to the programme. A full, formal review of the pilot programme was undertaken before full implementation. The long-term aim of the implementation team is to build the poka-yoke process into the normal way of doing things. This is expected to take at least three years.

CONCLUSION

The company has taken a pro-active top-down approach to the introduction of poka-yoke. The steering group ensured that adequate resources were available and appointed a working 'implementation' team. This team approached the introduction of poka-yoke in a methodical planned way. They ensured that the principles and concepts of poka-yoke were defined and understood within an organisational framework and introduced a structured training programme to explain and illustrate the company's approach.

In time all employees will understand and use the concepts and practical principles of poka-yoke and poke-yoke will become just another problem-solving method to be used in the continuous improvement process at the site.

REFERENCES

[1] Shingo S *"Zero Quality Control: Source Inspection and the Poka-Yoke System"*, Cambridge, Mass, Productivity Press, (1986).

[2] Chase, R.B and Stewart, DM *"Mistake-Proofing: Designing Errors Out"*, Cambridge, Mass, Productivity Press (1995).

FURTHER READINGS

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About the Author

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