XYZ DEFECT CONTROL: A Case Study from NSK Europe

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NSK Bearings, County Durham, produces rolling bearings, vital features in the machines of modern society, from cars to computer disc drives. In themselves bearings may look like fairly unexciting lumps of metal, but their accuracy (to 10ths of microns) reveals the true challenge of consistent mass production. With many famous companies amongst their customers, such as Black & Decker, Bosch, VW and Toyota, and with lives dependent on accuracy and reliability, quality control is critical. The target for delivered quality is 0ppm – resulting from a philosophy of zero defects. Achieving such an objective consistently requires total commitment to quality control.

The technology within the machines in the factory is awesome, but running high-tech facilities is only one piece of the jigsaw. The company believes that looking after and developing their employees is a critical success factor. Trust and support of their staff does, however, have to be backed up with clear policies and procedures. In the bearing factory, the average age of the 750 employees is 35. They look for people who will fit into their operations and make a positive long-term input. The policy is to bring in people young and develop them in an environment rich in best practices. Attitude and enthusiasm are regarded as having higher importance in the recruitment process than raw qualifications. Business and manufacturing excellence derive from the fact that they do not just pay lip service to quality methods: they practice them at all levels.

The nature of the business requires the presence of formal quality and environmental management system accreditations (QS 9000/ISO 14001). Customers demand such accreditations as standard 'qualifiers'. Introducing and maintaining these involves a lot of time and effort. In this company's view, such accreditations may be over-rated and given too much status in signalling a company's capability to the outside world. They contend that once achieved, they do not necessarily assist the path of continuous improvement to the extent that some (commercially motivated) promoters claim. Manufacturers must look beyond such accreditations for continuous improvement inspiration. An example is application of the Business Excellence Model - providing a more holistic view of an organisation's current capability – helping to drive improvements that are necessary to compete with rivals in such an aggressive market.

BASIC APPROACH TO QUALITY

With consistent achievement of world class quality (6 years continuous Zero ppm for Toyota), NSK have learned a thing or two about how to make it happen. It's not just about doing the right things – it's also about doing things right! Simply applying modern tools isn't sufficient – choice of core actions is a critical success factor. You need a focused system and to choose key areas of concentration:

- Training
- Authority
- Control methodology
- Mistake-proof checking
- Equipment capability

People really are the most important factor. People make quality, not machines. The factory is highly automated with associated high capital investment and man: machine ratios are good. Worker discipline is imperative in such an environment. Training in manufacturing systems and understanding of quality is of paramount importance.

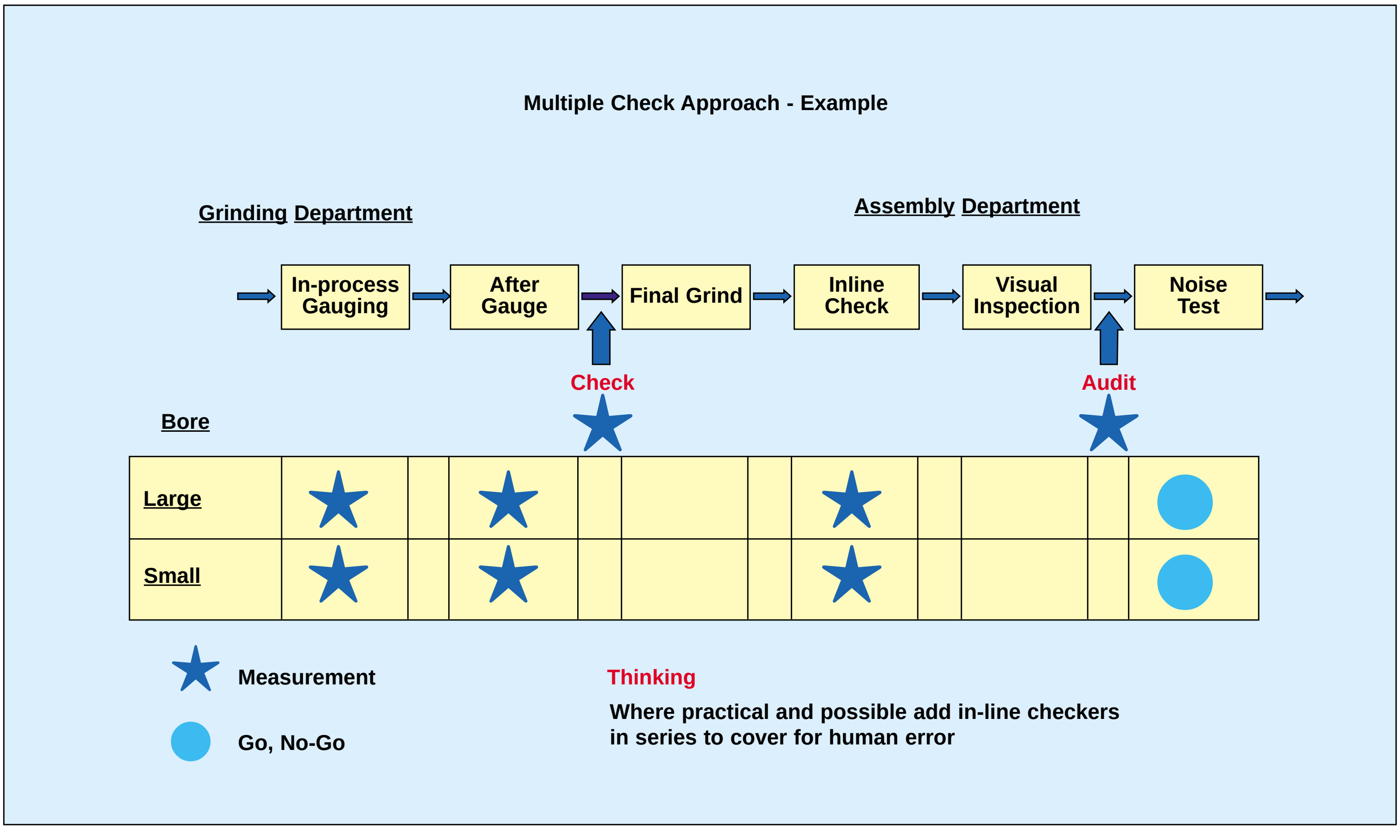
Operators are given authority to take action – that is, responsibility for quality, output, for housekeeping and other issues. Letting people on the line stop the machine is normal practice, there is no need to wait for a supervisor to make that decision. Operators are taught to measure components and judge whether quality is in jeopardy. They will stop the process even if only based on a 'felt' quality doubt. In the early days following training new employees tend to react with excessive safety. Confidence and capability is allowed to grow in an environment where product quality is protected. A company must give leeway for people to learn and gain confidence. This engenders responsibility and gives authority to take action. It is interesting that the company use the word authority rather than empowerment – it sounds more disciplined and positive.

Control philosophy is another critical success factor. Product attribute control is based on SPC but is not highly visible in the traditional sense. NSK's contention is that you don't rely on statistics to control quality, you rely on people. You do not need a chart to recognise a trend you are trained for. Even the best machines and systems in the world on their own will not result in zero ppm quality. This approach can create difficulties. Customers in Europe expect a high precision company to use classic SPC 'paraphernalia', with x-bar and r charts. How many companies have invested in SPC systems (often PC based) and only succeeded in providing comfort to customers? Here the approach is a holistic one, based on full process understanding. If visitors go to the shop floor before having had the company philosophy explained to them they can be worried by the lack of charts. Managers have learnt to invest time in visit itineraries to cover this aspect even if customers do not want it! The proof of effectiveness is found in the outgoing quality record (0ppm). Other tools and techniques include many that are familiar: Poka-Yoke (mistake proofing); in-built automatic check systems (some sophisticated electronic systems; others very simple mechanical devices). Where products move from one process step to the next, opportunities are taken to install effective mistake proofing devices that do not add to process or labour costs and are mostly maintenance free. The cumulative effect of these approaches is reliable zero defect achievement.

MULTIPLE-CHECK APPROACH (MCA)

Is a multi-check approach going back to inspection? The NSK philosophy is that where it is appropriate you install multiple-check controls for application critical-features. Sampling systems can be a useful quality management tool but are often inappropriate in a zero defect regime. Similarly, process capability monitoring is not enough. A common pitfall of SPC is that people see a control chart on a machine, with nice neat plot lines, and take (false?) comfort that quality is in control. What is the reality? It could be an accurate reflection of actual process quality, or little more than shop floor 'wallpaper'. How accurate is it? Did the operator fill it in at the end of the shift? The common problems of SPC implementation need not be repeated here.

The multi-check approach consists of automated checking devices, arranged within the manufacturing lines (some are existing mistake-proof devices). There are typically 2-3 detection points for any individual key product feature. Each

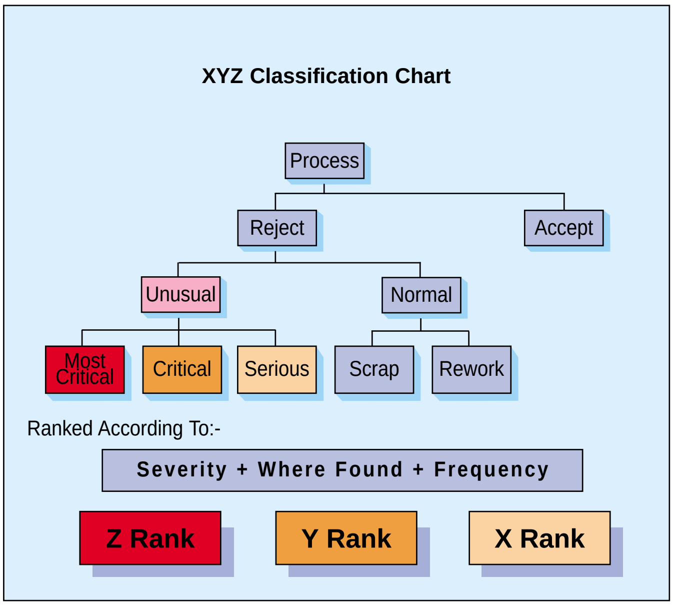


check is highly effective and arranged 'in-series' along the process stream. Machines are usually reliable these days, however, people can and do make mistakes. Even the best people will have a bad day and generate errors of handling or judgement. So systems are needed to pick up those genuine errors. A multiple check approach protects the customer and also the operator. The net result of the multiple arrangement is to create an extremely low practical risk of errors escaping the manufacturing system. Its effectiveness is witnessed in the consistent 0ppm performance.

XYZ DEFECT CONTROL SYSTEM

It is the simplicity of this system that makes it so effective. Huge emphasis is placed on:

- Classification of the defect
- Communication of the problem
- Action on that problem



Any manufacturing process has only two possible outcomes: acceptable product or rejected product. Rejected product can also be classified into two groups: 'normal' (meaning typical rejects) and 'unusual' (abnormal in either nature or magnitude). In most companies, normal rejects are already managed through systems designed to capture cost or output losses (scrap and re-work systems). What can be missing in the management of quality is effective treatment of abnormal events. Such events may occur at relatively low frequencies (for example, monthly rather than daily). Without a systemised approach to their management great risk can be present to outgoing quality. It is not safe to take comfort from the low frequency and assume low risk. NSK developed the XYZ system to effectively deal with the threat of unusual product events occurring in manufacturing operations. The system borrows core principles from FMEA (Failure Mode Effect Analysis) - although the nature of the implementation and how it is applied practically in the work place is believed to be unique.

Three levels of unusual defect are distinguished:

- Serious
- Critical
- Most critical

The level of ranking applied to any particular product defect is estimated from a simple risk evaluation (FMEA based): (SEVERITY x WHERE FOUND x FREQUENCY). For instance, in the manufacture of bearings, a crack could contribute to a serious breakdown. Engineers detail all the separate process steps and note what could happen and the outcome should that defect ever reach the end customer. They then try to find ways in which they can detect such outcomes in the existing process. Based on this evaluation a rating level is given to each problem (X, Y or Z):

X = Low risk, or higher risk but detected early in process

Y = Medium risk detected before final detection mechanisms

Z = High criticality defect anywhere in the process

Emphasis is placed on the escalation of action where problems of greatest potential effect are discovered in plant.

XYZ Matrix - Example

DEFECT TYPE →

XYZ MATRIX - PRODUCT GROUP "A"

PROCESS SEQUENCE ↓

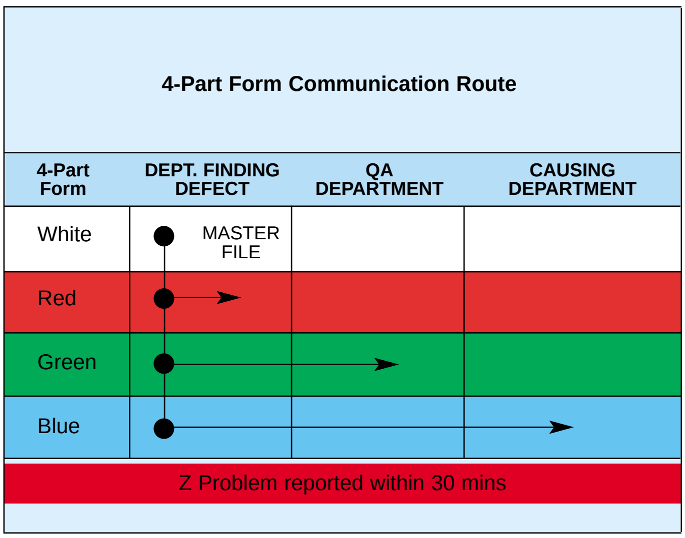
	L					HT, HFQ								
	MIXED MATERIAL	DIMENSIONAL FAULT	FEINT MARKING	NO / INCORRECT MARKING	UNGROUND AREA FAULTS > 10 PER BATCH	OUTER RING HARDNESS < 60HRC > 64.2HRC	SHAFT HARDNESS <60.5HRC > 64.2HRC	ABNORMAL MICRO / PATTERN / ECD	SHAFT BEND OUTSIDE TOLERANCE	SOFT RING SHAFT IN FLOW	SOFT RING / SHAFT OUT OF FLOW	MATERIAL CRACK	G1 GRINDING CRACK	G1 GRINDING BURN
MACHINING	Z											Z		
MARKING		X												
HEAT TREATMENT			X	Y		Y	Y	Y	X	Z	Z			
G1 GRINDING					X	Z	Z						Z	Y
G2 GRINDING									Y					
ASSEMBLY ECT											Z			Z
DIMENSIONAL CHECK														
A & SHAFT MATCHING														
RAIL INSERTION														

ASSIGNED XYZ RANK

The system exists to keep any problems within the company, and to prevent escapes to the market. Customers want reliable, consistent products – first time, every time: they are not interested in how well you manage a quality problem that you have allowed to get out!

When problems are detected in plant they are ranked according to the XYZ matrix. This document is the guts of the system: containing the expert knowledge relating to the types of defect possible and their potential detection position. From this 'database' any employee can quickly and easily determine an accurate ranking for any concern. Generating this matrix is the key activity in XYZ implementation, needing input from all functions involved in the manufacturing process. Once completed it needs only infrequent update according to changes in process methods or to reflect new insight from external feedback. A benefit of applying this matrix is the generation of consistency across sites in a large organisation where similar processes are applied.

Utilising simple pro-forma documents, the vital step of communicating the concern can start. It is a very simple system. The four-part document is rapidly routed around the organisation structure, across department boundaries and hierarchies – in both manufacturing and quality functions.



Note the particular emphasis on the Z problem: it must be reported within 30 minutes. There must be a management meeting within 60 minutes. This urgency is the key to consistently high levels of quality control. That rapid communication, via hard copy documents, is not dependent on somebody reading an email, but is personally delivered to the appropriate person for immediate action. This is well beyond what is required by accreditation standards (QS 9000 or ISO 9000).

If the defect is not critical but might reduce performance, it is generally classified as a Y problem, and drives a meeting of group leaders within a day. Less critical problem (X problems), although actioned promptly, are reviewed weekly through the supervisory levels to ensure follow-up has taken place. This means management attention is always focused to the critical few (Z level).

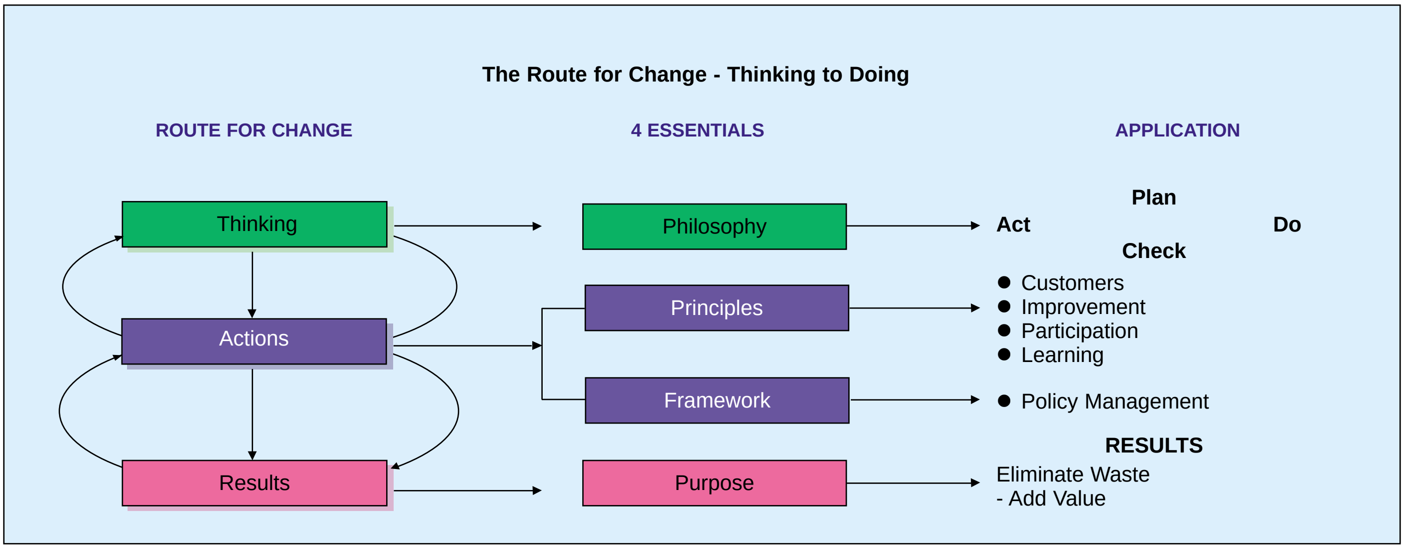
The XYZ system can be applied to any process – whether it is making bearings, cars, ice lollipops or providing a service – it has a broad application. The most important point is that communication is great, but action is more important. In a safety-critical product like bearings, only one standard is allowed: perfection. There is no passing the buck. A Total Quality Culture is in operation. There are many versions of it, but success relies on practical as well as conceptual understanding. It also means that the whole supply chain has to be involved.

MAINTAINING THE STANDARDS

Application of the Business Excellence Model is seen as an important component of continuous business improvement. Leadership is seen as a critical issue in managing for excellence, providing:

- Clarity of purpose and goals
- Consistency of performance, direction and intent
- Control of strategies and plans through measurement and review

Their approach considers the process of turning thoughts and



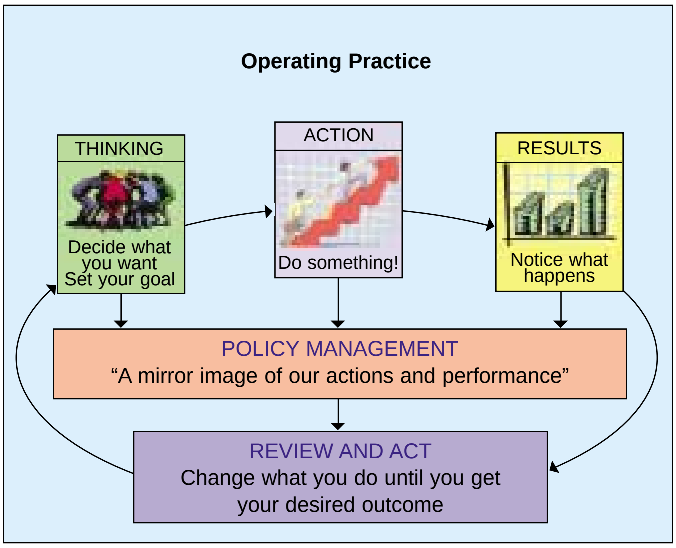
ideas into firm business plans, with tangible outcomes that benefit the bottom line. The approach is summarised below in diagrammatic form - the route for change: Thinking to Doing.

The key tools employed in moving from thought to action and ultimately creating the results are:

- Policy and strategy management
  - Planning
  - Communication
  - Deployment
  - Measurement
  - Review
- The Business Excellence Model
  - Assessment
  - Benchmarking
  - Feedback
  - Measurement

Change management is nothing new, but driving effective change needs a clear vision, good leadership and consistent approaches. The classic PDCA cycle enables managers to visualise with clarity and purpose and with focus on results.

The company recognises that it is the integration of technical 'know-how', careful management and good human resource policies that result in the competencies they need. By using traditional (but highly detailed) vision, mission and policy development, they align and connect all the activities of the company.



Sounds like textbook stuff! The difference is, this company does it so thoroughly and consistently, they make it work. There is a discipline in their operations that is hard to copy, although most of the management tools and techniques used are well known. Benchmarking is out of fashion, but role models for excellence are still needed. Here is an exemplar that demonstrates that in a world of increasing automation, people still matter and are a vital part of the process.

This article is based on a workshop held at Heriot-Watt University, 2001.

About the authors

Philippa Collins PhD is an Associate Member of the Institute and currently lectures on business systems applications and strategy in the School of Management, Heriot-Watt University. Her research focuses on the effects of automation on management and working practices. She has recently written "Virtual and Networked Organisations" (Capstone) which will be published later in 2002.

Tom Richardson MSc has 25 years experience in the manufacture of high volume, high precision automotive and industrial components.

Major cost reduction success through the integration of high-level quality tasks into manufacturing roles was the subject of his MSc research. His passion is to make systems logical and simple for the user, easing implementation for a wide audience level. He is currently Quality Assurance Manager, NSK Bearings Europe Ltd.