

# Achieving Product Reliability - The Management Role

## Background

The manufacturing industry has, over a period of many decades, developed and promoted the notion that Quality and Reliability are distinctly different attributes requiring specialist administration. Many organisations perceive design to be an attribute rather than a process and quality to be product specific and the responsibility of production. Engineering project managers who delegate responsibility for Product Reliability to others, rather than sharing such responsibility with others, surrender their control over the determinants of success or failure. Many areas of the manufacturing industry have made little or no progress in improving Product Reliability over the last half century. It may help the reader to appreciate some of the background to this lack of progress if we start by examining the European definitions of Quality and Reliability.

### *Quality*

The Quality of a commodity is defined as "the degree to which it meets the requirements of the customer. With manufactured products, Quality is a combination of Quality of Design and Quality of Manufacture".

### *Reliability*

Reliability is defined as "the measure of the ability of a product to function when required, for the period required in the specified environment. It is expressed as a probability".

In both of these definitions there is a clear recognition of dependence upon *customer (user) requirements*. There is, therefore, an implied understanding of such requirements and it is at this point that both supplier management and customer either verify the validity (realism) of the stated requirements or risk heading off into whatever direction the assumed requirements may lead them.

## Standards and Specifications

The dominant influence on misunderstanding of user requirements derives from the slavish use of "Standards". Military and Commercial Standards were developed to provide guidance in managing the technical processes of acquisition programmes. These Standards were never intended to provide cut and paste recipes for meeting "on time and within budget" targets. Blind reliance on Standards and Specifications will inevitably lead to high risk acquisition programmes in which product is unreliable and fielded late at far greater cost than planned.

Wherever rapid technological advances are being managed standards can, and frequently do, frustrate quality and reliability initiatives. Anyone who has participated in the evolution of a new standard or specification will readily appreciate the inordinate length of time taken by committees and working groups in bringing a new standard or specification to First Draft stage. In the time normally taken to reach Final Issue stage technology will usually have moved on.

## Poor Product Reliability

Here are some of the key disabling characteristics of poorly managed acquisition programmes:

- Indiscriminate and ill informed use of Standards and Specifications
- Control of acquisition strategy by the end user
- Sacrifice of informed technical assessment in favour of milestone driven administration
- Failure of management to understand the difference between cost and price
- Ignorance of the industrial processes of design, test and production
- Promotion of "test to pass" rather than "test to fail" strategies
- Focus on cost and schedule factors to support management decisions to the exclusion of informed technical assessment
- Use of flawed reliability prediction tools as a contractual loop hole for delivering shoddy goods

- Employment of managers who do not understand the processes they manage

### **A Salutary Lesson**

A recent article published in the "SOLDIER" journal serves to illustrate both the punitive cost of the "test to pass" culture and the power of informed technical assessment and engineering judgement over the traditional misapplication of statistical reliability modelling. It concerns the dramatic improvement in reliability of the SA80 rifle following a detailed root cause analysis of design and manufacturing problems. A summary of faults, corrective actions and reliability improvement is provided below.

SA80 Reliability Improvements.

1. Gas System  
Old - Parts break under extreme temperature conditions.  
New - Parts manufactured to higher tolerances from higher grade material.
2. Firing Pin  
Old - Breaks under high intensity firing conditions.  
New - New design incorporates a conical profile that aids guidance and seating.
3. Bolt  
Old - Unable to consistently extract and eject fired case at elevated temperature.  
New - Bigger, stronger extractor with redesigned bolt.
4. Cocking Handle  
Old - Empty cases thrown back into weapon's working parts.  
New - Cocking lever redesigned to deflect spent cases away from weapon.
5. Hammer  
Old - Bolt and other firing system parts still moving during automatic firing.  
New - Centre of Gravity and mass changed to strike firing pin 4 msec later.
6. Magazine  
Old - Not durable and easily prone to damage.  
New - More robust material, stiffer spring and deeper spring platform.

The SA80 is now considered to be the most reliable 5.56 mm rifle in the world. This reliability improvement has been achieved by detailed root cause analysis, the implementation of well engineered corrective actions and meticulous attention to detail, not by the blind application of Standards and Specifications nor by the manipulation of mathematical reliability models. Furthermore, this reliability improvement could, and should, have been achieved during the weapon design and proving phase before commitment to production.

### **Electronic System Reliability**

Reliability Prediction folklore asserts that system reliability is governed, amongst other things, by the number of components contained within the hardware design. In other words, more components mean more failures per unit time or poorer reliability. If this were true, then the Nation's motorways would be littered with stationary cars waiting for engine management systems to be replaced. Consumer product retailers would not be offering extended warranty deals on manufacturer's three-year guarantees. Mobile telephones, lap top computers and electronic organisers would not be carried in pockets, brief cases and car boots and still be expected to work when required to do so. In spite of all the evidence provided by the reliable performance of automotive, consumer, IT and communication products, the military still show delight and satisfaction when they take delivery of a system that works for more than a week without failure.

## **The Management Role**

In response to a recommendation for achieving reliability growth by the introduction of an accelerated ageing process based upon test realism, a manager replied "Never mind all this reliability stuff, I have a product to get out of the door". What this manager failed to acknowledge was the fact that the sooner he gets his product out of the door, the sooner it will come back for repair, again and again and again.

Here are some recommendations for managers who care about delivering reliable product:

- Make funding decisions based upon sound technical inputs
- Ensure that early design and test efforts are fully funded
- Recognise funding requirements to support test to fail strategies
- Understand product whole life environmental profile and ensure that project team share this knowledge
- Maximise the use of design analysis
- Ensure that design is mature before transfer to production
- Encourage design for required failure free operating periods, not for predicted failure rates
- Encourage disciplined supply management including Government Furnished items
- Ensure that production test requirements are understood during early design phase
- Base test strategy upon proper understanding of product whole life cycle, not cook book Standards and Specifications
- Ensure that all failures are analysed and considered for corrective action from the start of Full Scale Development
- Make Robust Design your legacy to manufacturing
- Ensure that manufacturing process is qualified before first delivery
- Use only manufacturing organisations with a proven (audited) manufacturing process capability
- Enable engineering to use all necessary Design Robustness, Environmental Stress Screening and Accelerated Ageing techniques by proper funding and training
- Promote and lead a resolve to achieve best possible in-service cost of ownership

For Managers who care more about ticking milestone boxes than delivering reliable product, enjoy your fat spares contracts and over resourced repair departments while you may. They are headed for disaster and may well take you with them.

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