Maintenance Myths, Mindsets & Mistakes
Part 2 – Improving Operational Reliability & Availability

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1. Abstract

This paper sets out some of the most common maintenance myths, mindsets and mistakes[1] that are made when attempts are made to improve operational reliability and availability.

Successful reliability growth and performance improvement is all about 'doing the *right* maintenance' on the equipment. Determining the '*right* maintenance' takes time and resources.

Experience has shown that the only way to make real, lasting improvement in the maintenance arena is by:

- Changing the way in which people think (ie dispelling all the myths, mindsets and mistakes that have been ingrained in maintainers' thinking over their working life)
- Providing an approach (such as RCM[2]) that encompasses a structure whereby the changed thinking can be brought to fruition.

The most common maintenance myths, mindsets and mistakes that are made when attempting to improve operational reliability and availability are summarised in the following paragraphs; a full explanation is given in the subsequent sections of this paper.

It is a myth that reliability growth and performance improvement can be achieved quickly by adopting a 'redesign' approach. Reliability growth or performance improvement approach is best achieved (and, usually, more cost effectively achieved) by optimising the *maintenance* carried out on the asset as it is today.

Over-reliance on OEM specified maintenance is a common mistake that maintainers make. It might be a quick and easy solution to the need to specify equipment maintenance but is rarely the most cost effective approach and often fails to achieve the necessary operational reliability and availability.

A common myth is that maintenance is all about preventing failures. Maintenance is actually all about managing the *consequences* of failure; in this way money spent on maintenance is spent where it will do the most good.

A common mistake is to focus effort on preserving the assets. Instead, maintenance should focus on preserving the *functions* of the assets.

2. Introduction

The last 20-30 years have been characterised by massive technological change and most industries have responded by investing heavily in automation and technology to reduce headcount, improve product quality, reduce unit price and improve safety and environmental integrity etc. The net result is that organisations are increasingly reliant on their assets to perform when required.

In some organisations, equipment failure is becoming increasingly intolerable and the consequences of failure can seriously affect safety and the environment or be expensive in terms of lost production or customer service. Some failures are sufficient to threaten the financial stability of the organisation or even force it out of business.

In other organisations equipment failure is much less severe but can still adversely affect profitability or customer service.

Regardless of the industry sector, organisations are striving to increase cost effectiveness – in most organisations improving equipment reliability (and hence availability) is the key to overall performance improvement and cost effectiveness. Successful reliability growth and performance improvement is all about 'doing the right maintenance' on the equipment.

The maintenance arena is littered with an assortment of myths, mindsets and mistakes which often mean that the resulting equipment maintenance does

[1] See also Maintenance Myths, Mindsets and Mistakes Parts 1&3, *Establishing Maintenance Task Intervals* and *The Maintenance Arena* respectively

[2] RCM – Reliability-centred Maintenance. Short-form definition: *"A process used to determine the maintenance requirements of plant and equipment in its operating context"*

not achieve the desired outcome, is frequently flawed (sometimes fatally!) and is sometimes plain wrong.

Current management styles demand 'instant results' preferably via a 'quick fix'. Frankly, it is a myth to think that quick-fixes work in the maintenance arena. Achieving reliability growth or performance improvement is neither quick nor easy; if it was, you would have done it by now!

Reliability-centred Maintenance [RCM] is an approach for determining the right maintenance for plant and equipment in its operating context. RCM is not a 'quick fix' but applied correctly, it can transform an organisation's approach to maintenance and hence lead to substantial improvements in equipment reliability and availability and hence overall performance and cost effectiveness.

Applying RCM correctly takes both time and resources. However, for an organisation with high value assets, the investment required to get the maintenance *right* is often a drop in the ocean compared with cost of getting it *wrong*. Sadly, few maintainers are praised for getting maintenance *right* – many, however, are lambasted for getting it *wrong.*

3. Reliability Growth through Redesign

Many reliability growth programmes and performance improvement schemes focus on making changes to the asset design; this approach attempts to change the design so that the probability of the failure occurring again in the future is reduced.

It is a myth that reliability growth and performance improvement can be achieved quickly by adopting a 'redesign' approach.

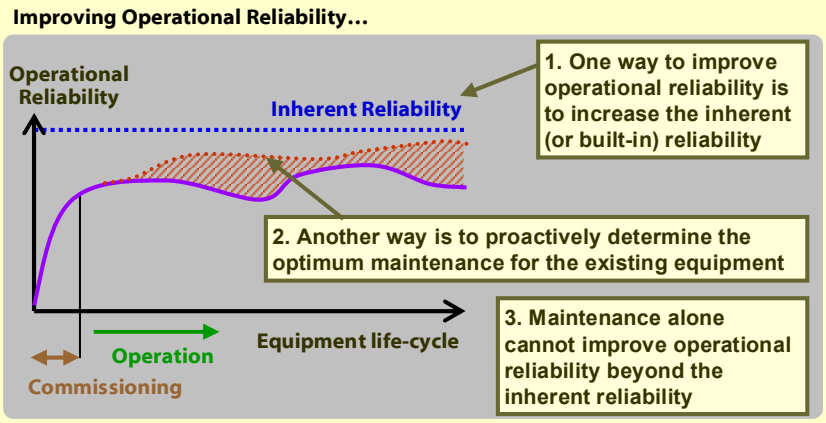
The 'redesign' approach attempts to improve the inherent reliability of the asset in the hope that this will also improve the operational reliability (ie what is actually achieved each day) of the equipment. Whilst design changes might alter the inherent reliability of the equipment, the operational reliability depends heavily on maintaining the equipment correctly; the operational reliability may, in practice, be woefully short of expectations if the correct maintenance is not carried out.

Achieving reliability growth and performance improvement is possible by making design changes but there can be downsides:

- The cost of making design changes can be high (particularly if there are a large number of similar assets that all need to be modified) and it can take a substantial length of time (particularly in high risk industries where the design approval stage is lengthy)
- Engineers and maintainers often have an unshakeable belief in their ability to improve on the existing design. Whilst many redesigns achieve what is intended, some are less successful and some may actually reduce the inherent reliability (by introducing more failure modes into the system)
- Achieving reliability growth and performance improvement through design change is (largely) reactive; the organisation waits for the failure to occur and then makes the redesign. The net result is that it can be a very long haul before the operational reliability achieves the desired levels (particularly if there is a large population of assets).

RCM derives the optimum maintenance for the equipment in its current operating context and this is (usually) a more cost effective approach for improving the operational reliability of the equipment. RCM is also a proactive approach in that it attempts to identify credible failures that could occur in the future; applied correctly, RCM secures improvements in operational reliability more quickly than a 'redesign' approach.

Clearly, if the plant is incapable of meeting the system requirements to the satisfaction of the user or if the inherent reliability is not sufficiently high then a redesign will be necessary (simply because maintenance cannot achieve more than the inherent equipment reliability and cannot increase the performance of the equipment beyond the inherent system capability).



It is a myth that reliability growth and performance improvement can be achieved quickly by adopting a 'redesign' approach. Determining the optimum maintenance for the existing equipment is nearly always more cost effective.

In summary, RCM targets maintenance as a reliability growth and performance improvement approach and will only specify a *One-off* Change (which might include redesigning the asset) as a last resort. RCM identifies how to get the best out of the asset as it is today; ultimately this is usually much more cost effective than making design changes to the asset.

4. Preventing Failures

Consider the situation where an organisation has four identical centrifugal pumps on site with the following operating contexts:

Pump A supplies chilled water to a cooling system on a piece of process equipment – if it fails, the absence of chilled water means that production will stop.

Pump B supplies chilled water to a similar cooling system on a piece of process equipment but in this instance, there is a standby pump (Pump C) which is used if pump B fails.

Pump C (as described above) is a protective system that is provided as a standby to pump B in order to keep the process going if pump B fails.

Pump D is fitted adjacent to the bund of a large outside fuel tank to remove rainwater that collects in the bund. Pump D is started and stopped manually by an operator as required.

In the RCM process, maintenance is only selected if a maintenance task is *worth doing*, which will depend in turn on the consequences of failure:

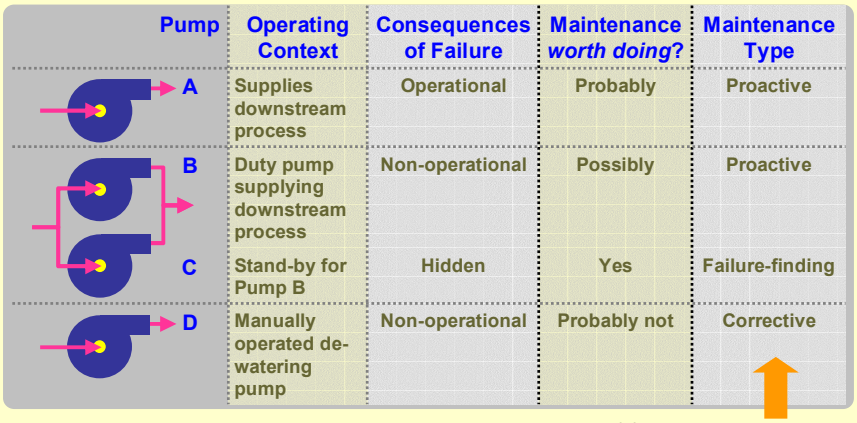
If pump A fails, production will be lost and so it is likely that some form of routine maintenance (to predict or prevent the failure) will be worth doing to this pump.

If pump B fails, production is not lost because its failure is protected by pump C; for pump B, therefore, the consequences of failure are much less severe than those for pump A and so routine maintenance is much less likely to be worth doing. Maintenance on pump B will be justified only if there is a risk of substantial secondary damage to the pump if it is allowed to run-to-failure or if the combined probability of pump B failing and pump C being in a failed state is intolerable.

If pump C fails, the problem is that no one knows it has failed unless pump B also fails; a routine maintenance task to confirm whether or not pump C has failed will probably be worth doing. The routine maintenance that is carried out on pump C is, therefore, likely to be very different from the maintenance carried out on pump A and may only involve checking to see if pump C has already failed (in order to ensure that the combined probability of pump B failing and pump C being in a failed state is tolerably small).

If pump D fails there will be no loss of production but it will be necessary to repair the pump (ie carry out corrective maintenance). For this pump, routine maintenance is probably not likely to be worth doing and the pump will most probably be allowed to run-to-failure (unless there is a risk of substantial secondary damage to the pump if it is allowed to run-to-failure).

Managing the Consequences of Failure…



*Maintenance is about managing the **consequences** of failure – run-to-failure may be more cost effective than trying to **prevent** the failure*

A common myth about maintenance is that maintenance is all about *preventing failures* - the above example, however, illustrates the fallacy of this myth (which is further compounded by the metrics that maintenance engineers are tasked to improve such as MTBF, the ratio of proactive maintenance to corrective maintenance etc.).

In summary, therefore, maintenance is not primarily about preventing failures but is actually all about managing the *consequences* of failure – maintenance departments should focus on managing failures that have serious consequences and hence allow failures with lesser or trivial consequences to occur. By allowing some failures to occur (ie those with low or trivial consequences), maintenance departments can free-up scarce resources to focus attention on those maintenance activities which have most effect on the safety and performance of the equipment.

In this way, RCM ensures that money spent on maintenance is spent where it will do the most good.

5. Preserving Assets

Going back 20-30 years, the focus of maintenance was to overhaul equipment periodically (often annually to coincide with plant shutdowns) and bring it back to an 'as new' condition. Most organisations have moved on from such invasive (and often unnecessary) maintenance and the annual shutdown is either a distant memory or on a much different scale than was the case previously.

There remains, however, a mistaken belief in some maintainers that they should focus their efforts on *preserving* the assets – the rationale being that an asset in 'good' condition will perform well and give little or no trouble. There are two main reasons for this entrenched belief:

- OEMs recognise that most organisations base their maintenance on manufacturer's recommendations and so there is a tendency for OEMs to over-specify maintenance and focus on asset preservation because this will consume plenty of spare parts and/or generate lucrative maintenance contracts downstream
- There remains a legacy of maintainers who either date back to the years when preventive maintenance (in the form of overhauls/replacement) was considered to be the best approach or they worked for/with other maintainers that took such a view (which has subsequently been passed on). In either case, these maintainers have a deep conviction that overhauling or replacing equipment to 'as new' is the 'proper' way to maintain assets and will take every opportunity to 'preserve' the asset in this way.

Each of these is discussed further in the following sections:

Original equipment manufacturers/ suppliers

Many maintainers believe that OEMs are in the best position to recommend appropriate maintenance for the equipment they supply but, in practice, this may not always be the case for a number of reasons:

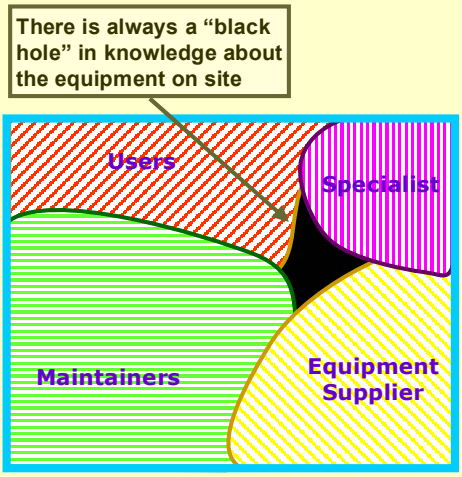
- Surprisingly, some OEMs have limited hands-on experience of working with the equipment they supply. This is particularly the case where the finished asset is an assembly of equipment bought in from a range of other suppliers. Furthermore, OEMs rarely have experience of the particular operating context in which the equipment is being used and the consequences that arise if the equipment fails
- The OEM will probably not have any prior knowledge of the maintenance facilities, technician skills or technology available (eg the presence or absence of condition monitoring equipment within an organisation) to the end-user
- It is in the commercial interest of the OEM to over-specify maintenance to ensure that the recommended maintenance consumes spare parts and/or generates lucrative maintenance contracts downstream. This can saddle the end-user with excessive costs for years.

The net effect is that any maintenance specified by the OEM will often be something of a shot in the dark, probably very generic and have to cater for typical-worst-case in respect of both equipment usage and end-user maintenance capability – not a good foundation on which to base the future maintenance for major capital plant.

In conclusion, over-reliance on OEM specified maintenance is a common mistake that maintainers make. Why, therefore, do so many maintainers rely on OEM specified maintenance? The reason is that the OEM maintenance option is a quick and easy solution that absolves the maintainer of the responsibility for determining the maintenance. The downside is that OEM specified maintenance is rarely the most cost effective approach in the long term and often fails to achieve the necessary operational reliability and availability.

In practice, those closest to the asset (ie the maintenance and production personnel) are usually better placed to determine the maintenance requirements of the equipment because they have hands-on experience and understanding of the equipment and what can go wrong. RCM provides the structure and process for determining the optimum maintenance for the assets. RCM is zero-based which means that each analysis starts with a clean sheet of paper, deriving the final maintenance schedule from scratch (without assuming that the current maintenance is either correct or incorrect). The strength of this approach is that "tradition and practice" is by-passed and "excess baggage" avoided.

OEM Specified Maintenance…



- *Some OEMs only have limited experience of working with the equipment they supply*
- *The OEM will probably not have prior knowledge of the operating context on site*
- *It is in the commercial interest of the OEM to over-specify maintenance*
- *OEM specified maintenance is rarely the most cost effective approach in the long term and often fails to achieve the desired operational reliability and availability.*

Just occasionally, the RCM analysis team will need the support of the OEM – in which case, a field service technician is usually the best source of information.

Another reason why maintainers rely on OEM specified maintenance is the issue of equipment warranty. When equipment is new, end-users often feel obliged to follow the OEM's maintenance recommendations so as not to invalidate any warranty; this may or may not be a legitimate concern.

At the end of the day, a warranty is 'an insurance policy' which OEMs are obliged to provide as part of the equipment supply contract. In reality, OEMs are unlikely to expose themselves to excessive risks during the warranty period and so it may be much cheaper for the end-user to avoid the burden of the OEM specified maintenance (thereby breaching the warranty terms) and effectively 'self-insure' (ie accepting that they may 'lose' on occasions).

In practice, the 'warranty issue' is a short term problem and the end user has three options:

- Follow the OEM specified maintenance during the warranty period in order to avoid a breach of warranty - This is worthy of consideration if one or more of the following apply:
    - the repair cost in the event of failure is likely to be high
    - the technology employed is sophisticated and/or novel
    - the end-user does not have the requisite skills to determine appropriate alternative maintenance
    - the OEM maintenance requirements during the warranty period are not onerous
- Ignore the OEM specified maintenance and determine the most appropriate maintenance for the equipment in its operating context
- Ask (or require) the OEM to work with the end user to determine the maintenance requirements of the equipment using RCM (at the design stage) and provide a warranty based on the maintenance developed.

'Old school' maintainers

As discussed in the previous section, the focus of maintenance some 20-30 years ago was to preserve the equipment condition by overhauling or replacing periodically in order to bring it back to an 'as new' condition. This is sometimes referred to as 'preventive maintenance' and is founded on the belief that equipment is more likely to fail as it gets older – hence, by overhauling or replacing the equipment periodically failures will be 'prevented'.

There remains a legacy of maintainers who either date back to the years when 'preventive' maintenance (in the form of overhauls or replacements) was considered to be the best approach or they worked for/with other maintainers that took such a view (which has subsequently been passed on). These 'old school' maintainers are usually very well intentioned but often mistaken; they have the unshakeable belief that returning the equipment to an 'as new' condition is the 'proper' way to do maintenance.

The RCM process is designed to ensure, as far as possible, that the optimum maintenance is specified for the equipment but experience has shown that problems can arise when corrective maintenance is required. For the 'old school' maintainers there is a very strong desire to carry out more (frequently much more) corrective maintenance than is strictly necessary. The desire to return the equipment back to its original condition re-surfaces and a 'whilst we are about it' attitude sets in which results in more extensive (and often intrusive) corrective maintenance being carried out than is strictly necessary. The corollary of these actions is that a well intentioned maintainer inadvertently introduces infant mortality into an otherwise stable system (ie the initial, poor conditional probability of failure that often occurs with new or overhauled equipment)

Clearly good engineering practice must prevail in that it is sensible to fit, say, new gaskets when a component is re-assembled; however, the temptation to replace all the (perfectly good) bearings (because we have the equipment in

pieces) should be avoided unless there is a compelling reason to do so.

In conclusion, therefore, many maintainers need to have their thinking re-programmed away from the desire to preserve equipment condition by returning it to its 'as new' condition when corrective maintenance is carried out. Changing this engrained thinking is not easy and training is a starting point (but these maintainers will continue to need support and guidance). The goal should be to carry out only the corrective actions necessary to address the original failure.

The way forward

RCM is not about preserving assets - the focus of the RCM process is to preserve the *functions* of the assets. It does so by focusing on what the user or owner of a physical asset wants the equipment to do in its current operating context. RCM is applied on a 'system' basis (rather than a component-by-component approach); this ensures that the correct maintenance is determined for equipment within the system and according to the operating context of the system. In this way the resulting maintenance is very focussed and excessive maintenance is avoided.

6. Conclusion

The drive to improve cost effectiveness has led organisations to focus on increasing equipment reliability (and hence availability) so as to improve overall performance and cost effectiveness). Successful reliability growth and performance improvement is all about 'doing the *right* maintenance on the equipment'. There is a great temptation to improve cost effectiveness by reducing maintenance budgets – this works in the very short term but not in the medium and longer terms.

The maintenance arena is littered with an assortment of myths, mindsets and mistakes which often mean that the resulting equipment maintenance does not achieve the desired outcome, is frequently flawed and is sometimes plain wrong. In particular, it is a myth to think that quick-fixes work in the maintenance arena. Achieving reliability growth or performance improvement is neither quick nor easy; if it was, you would have done it by now!

Reliability-centred Maintenance [RCM] is a proven approach for determining the *right* maintenance for plant and equipment in its operating context. With its beginnings in the demanding civil aviation industry, RCM is not a 'quick fix' but applied correctly, it can transform an organisation's approach to maintenance and hence lead to substantial improvements in equipment reliability, overall performance and cost effectiveness. RCM optimises the maintenance for the on-site equipment and in so doing ensures that money spent on maintenance is spent where it will do the most good.

Applying RCM correctly takes both time and resources. However, for an organisation with high value assets, the investment required to get the maintenance *right* is often a drop in the ocean compared with cost of getting it *wrong*. In brief, the return on investment for RCM is substantial provided that the assorted maintenance myths, mindsets and mistakes are dispelled and the *right* maintenance is implemented.

7. Further Information

This paper was written by Simon Deakin and Steve Bailey of Mutual Consultants Ltd. See also Maintenance Myths, Mindsets and Mistakes Parts 1 & 3, *Establishing Maintenance Task Intervals* and *The Maintenance Arena* respectively.

Please do not hesitate to contact either of us for more information on how RCM can transform equipment performance and achieve desired operational reliability and availability:

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