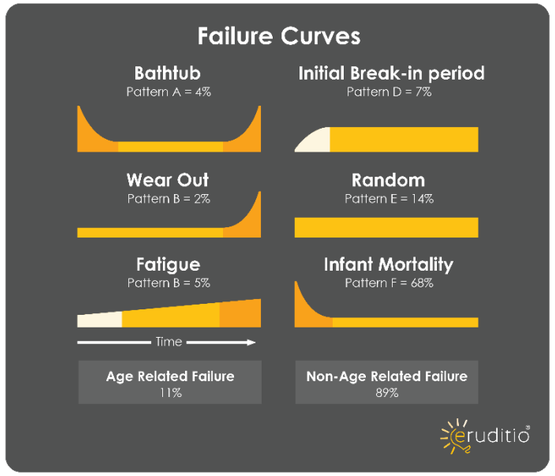
The non-age-related patterns highlight the fact that the initial start-up of the equipment is when the majority of failures will occur. This could be due to maintenance induced failures or manufacturing defects in the components, which is most common in electronic devices. Once the initial start-up period has passed, failures appear randomly over time. These patterns account for 89% of failure.



Now, these patterns state that the failures are random in nature, but that does not mean that they failures cannot be predicted or mitigated. It means that overhauls, time-based inspections, and time-based replacements conducted at a specific frequency are only effective in 11% of your asset applications. In the majority of applications equipment should be monitored for random changes in asset health, and at the right time, a proactive, corrective repair, replacement or overhaul is identified. This is known as Condition Based Maintenance (CBM), or even Don't Fix It Unless It's Broke!

To learn more about these failure patterns, the book *RCM II* by John Moubray is the best resource around. I highly encourage you to read this book if you are serious about improving your understanding of how equipment fails. As you look at these failure patterns, think about what percentage of PM's in your maintenance program today are fixed-frequency, time-based inspections, replacements, or overhauls that require the equipment to be disassembled? Reliability Centered Maintenance (RCM) is an effective approach for determining the appropriate strategy based on your understanding of equipment failures.

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How Equipment Fails: Understanding the 6 Failure Patterns

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Abstract

In the 1960's the failure rate of jet aircraft was high, even with the extensive maintenance programs that were put in place to prevent the failures. These maintenance programs, like yours, included overhauls, rebuilds and detailed inspections which required the various components to be disassembled. All of these activities were based on an estimated useful life of the equipment.

Under the guidance of the FAA, extensive engineering studies were conducted on all of the aircraft in service to determine the source of failures. United Airlines pioneered and published a report on the failures which turned the industry on its head. They concluded that only 11% of the failures were related to the age of the aircraft. The rest were random in nature or induced by the very maintenance work that was put in place to prevent them. Because of these findings, preventive maintenance programs were optimized, and aircraft reliability went up!

How Equipment Fails: Understanding the 6 Failure Patterns

How Equipment Fails

The report from United Airlines highlighted 6 unique, predominant failure patterns of equipment. Understanding these patterns illustrates why the reduction in maintenance could result in improved performance. The 6 known failure patterns are:

- Bathtub – A high probability of failure when the equipment is new, followed by a low level of random failures, and followed by a sharp increase in failures at the end of its life. This pattern accounts for approximately 4% of failures.
- Wear Out – The wear out curve consists of a low level of random failures, followed by a sharp increase in failures at the end of its life. The pattern accounts for approximately 2% of failures.
- Fatigue – Characterized by its gradually increasing level of failures over the course of the equipment's life. This pattern accounts for approximately 5% of failures.
- Best New – Also known as the "initial break-in period" curve and starts off with a very low level of failure followed by a sharp rise to a constant level at which time the inherent capability of the asset is reduced. This pattern accounts for approximately 7% of failures.
- Random – This is the absence of a failure pattern due to the sporadic, randomness of failures over the life of the equipment with no pronounced increases or decreased related to the life of the equipment. This pattern accounts for approximately 14% of failures.
- Infant Mortality – Shows a high initial failure rate post-installation, followed by a random level of failures over the remaining equipment life. This pattern accounts for 68% of failures due to the popularity of electro-mechanical devices in your facility today.

What These Patterns Tell Us

When looking at the failure patterns, the first three can be group together as the equipment having a defined life, in which the failure rates increase once the equipment has reached a certain age. "Age" may be time or usage such as hours, widgets produced or cycles. These failures are usually related to wear, erosion or corrosion, and are often simple components which come into contact with the product. Time-based failures only account for 11% of all failures.

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