Reliability Analysis

Is “Counting”

By Murray Wiseman and Daming Lin

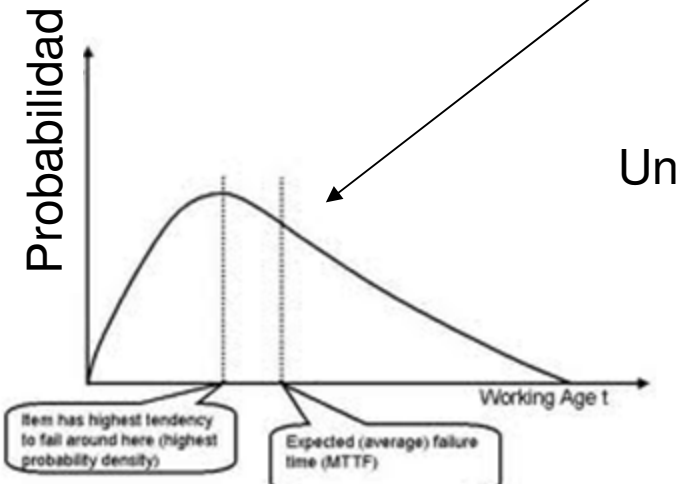
Financial analysis is counting money

Reliability analysis is counting instances of unreliability

Uno

Dos

Tres

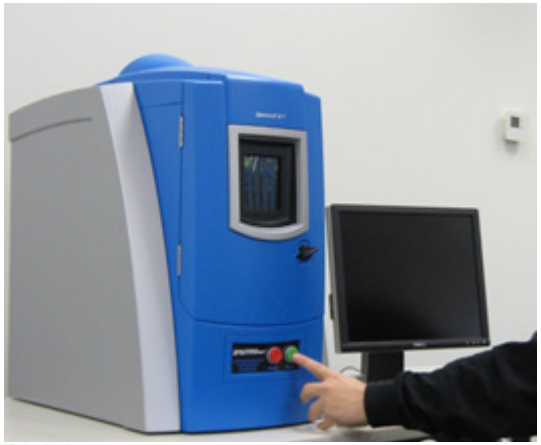


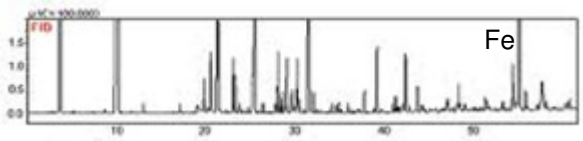
Uno

Dos

CBM Predictive Reliability Analysis

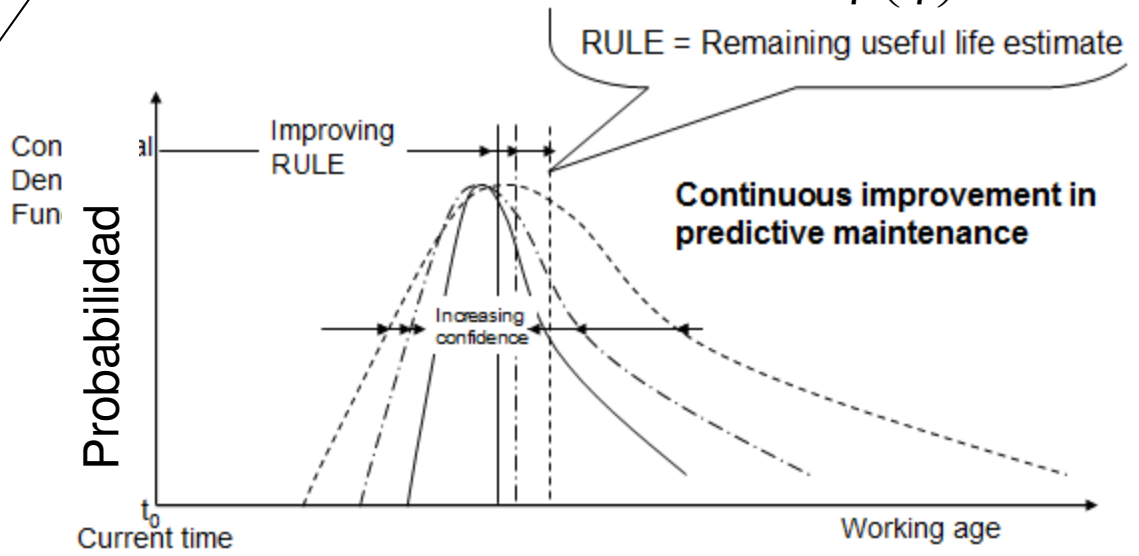
- Is counting the number of times certain levels of monitored variables precede a failure mode.





Proportional Hazard Model

$$h(t, Z(t); \beta, \eta, \gamma) = \frac{\beta}{\eta}\left(\frac{t}{\eta}\right)^{\beta-1} e^{\sum_{i=1}^{m} \gamma_i Z_i(t)}$$



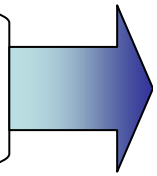
Predictive CBM RA in many CBM programs are characterized by: Large Shape Parameter.

Parameter	Estimate
Scale	2.63e+004
Shape	6.866
FE	0.3806
PB	0.1569

A large value for the Shape parameter, ß, means:

1. that the CBM parameters do not contain much predictive value. And
2. Unmonitored significant variables are inflating ß.

A large value for the Shape parameter, ß, raises a first important question…



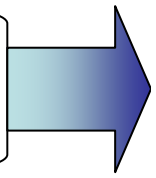
1. "Why are we doing CBM?"

If we answer, correctly, "Because we want:

- to detect potential failures as revealed by condition monitoring data in order
- to avoid the worst consequences of a functional failure."

Then we have a problem with large β. We are not actually doing CBM (as defined in the above two bullets) because large β means that decisions are mainly age based.

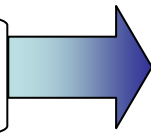
A large value for the Shape parameter, ß, raises a second important question…



2. "Why then am I bothering to monitor these variables?"

- Are you actually incurring the types of failures that oil analysis is targeting?
- If not, then turn your attention to the more important failures that take place in the fleet.
- The important failure modes (e.g. “reparaciones menores”) that actually cause functional loss and affect day-to-day operations and budget should drive the reliability improvement programs.
- If “Desgaste general”, for example, is not a big maintenance problem, then direct your attention to problems in auxiliary components (regardless of whether or not they are monitored by oil analysis).

A high value of ß will bring out yet another question for your consideration:

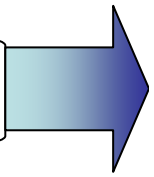


3. "What standard or criteria are the technicians and engineers using when reporting failure or potential failure?"

Here is a common scenario that illustrates the main problem.

- Assume engine overhauls occur at 12000 hour intervals.
- The teardown report indicates the discovery of several failure modes in a potential failure state.
- However a clear standard or definition is not used to make the potential failure versus suspension determination. A subcomponent or part may still have 5000 hours of useful life left in it.
- Yet the failure mode is judged (inaccurately) to have "potentially failed".

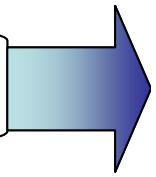
A high value of ß will, then, beg the fourth question



4. "What are we telling the model and what is the model telling us?"

- We are telling the model (by misreporting suspensions as potential failures) that failures tend to occur at a fixed time, which happens to be the time of our scheduled overhaul.
- And the model reports back to us, each time it is executed, the very same thing - that failure is age dependent (giving high ß).
- <u>This defeats the objective of CBM.</u>

A high value of ß will, inspire the fifth question…



5. What does continuous improvement in CBM require?

- Precise definitions for failure, potential failure, and suspension.*
- A true potential failure discovered at overhaul might be characterized by the technician's statement,
  - "Had it not been for the lucky timing of this overhaul, functional failure would have occurred within hours or days".
- **The main purpose of an LRCM project is to get precise information on "as-found" failure mode state.**

* The advantage of reporting changed moderately worn parts as *suspended* failure modes, is that the *software* will account for the uncertainty of when the part *would have* failed.