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Panel session on

RAM and PHM Synergy

Abstract

RAM (Reliability-Availability-Maintainability) Engineering is by now a mature discipline, tracing its roots back to the immediate post-World War II period. It deals with statistical properties of a population of assets, characterizes their failure modes and aims at optimizing the design of future equipment based on past experience, analysis and tests. It takes into account maintenance and operations context and also provides inputs to the elaboration of maintenance plans and logistic support.

RAM analysis at the design stage is typically model-based (while exploiting past data), and RAM Monitoring is data-driven but may be supported by models.

PHM (Prognostics & Health Management) emerged at the turn of the 21st century. It deals typically with individual assets which are equipped with sensors and aims at monitoring their health and its progressive degradation, so as to diagnose impending failures, and to avoid them by taking preventive actions when possible. Three main pillars of PHM are detection, diagnostics and prognostics.

PHM relies on model-based, data-driven or hybrid approaches.

Typically the two communities are separate for historical reasons.

The question we would like to raise here is: can the two communities both benefit from stronger links?

For example, the first stage in developing a PHM system is a failure mode, mechanisms and effects analysis (FMMEA), which is typically a RAM task. And one key expected outcome from a PHM strategy is increased availability.

While RAM focuses on estimating the probability distribution of the lifetime of a population, in a given environment with an average mission profile, PHM, on the other hand, focuses on predicting the rate of function loss for an individual asset, with a customized profile and context. RAM deals with discrete events (failures), and metrics such as failure rate and MTTF or MRL (mean residual life); while PHM deals with continuous, degradation data, and metrics such as health indicators (or indices) and RUL (remaining useful life). While RAM leads to maintenance decisions (such as spares management and determination of maintenance intervals) for a whole fleet, PHM supports maintenance decisions for one individual asset. The 'M' (maintainability) in RAM includes testability, which addresses the ability to detect and diagnose faults– an essential concern for PHM.

The IoT paves the way for individualized monitoring. Both RAM and PHM can be supported by machine learning techniques along with classical statistics. Therefore the borders between the two disciplines may be getting blurred.

Can cross-fertilization occur in both directions ? For instance, can PHM not draw on the considerable body of knowledge accumulated by RAM specialists over decades (including the venerable theories of the 'founding fathers', such as Barlow & Proschan, or Gnedenko, which PHM engineers often are not familiar with). And at the same time, cannot RAM Engineering be rejuvenated by machine learning algorithms and perspectives (which often RAM Engineers do not necessarily have in their toolbox) ?

Should corporate RAMS departments give way to RAM/PHM departments?

And what are the implications for higher education and research ?

Moderator

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