Reliability Engineering: A Brief Overview

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Reliability Engineering Overview

• Reliability engineering measures and improves resistance to failure over time, estimates expended life, and predicts time-to-failure

• What reliability engineers do?
  – Study ways to prevent failures
    • Robust Design
    • Monitor and correct degradation and damage
  – Develop and use models to assess damage, degradation, and aging
  – Predict the time-of-failure (e.g., MTTF, MTBF)
  – Assess complex system reliability
  – Develop prognosis and health assessment (PHM) methods
Evolution of Reliability Engineering

• Two Overlapping Themes for Modeling Life and Performance of Items Have Emerged:

  1. Data / Evidence Driven View:
     • Statistical
     • Probabilistic

  2. Physics Driven View:
     • Empirical: Physics of Failure
     • Physical Laws

• Examples of Areas of Applications
  – Operation (Repair, Maintenance, Risks, Obsolescence, Root Cause Evaluations)
1. Data View: Post WWII Initiatives due to unreliability of electronics and fatigue issues--asserts that historical failure data or reliability test data represent the truth
   - Predicted reliability from historical data exists as the likelihood of no failure
     \[ R(t; \theta) = \Pr(Time - to - failure \geq desired\ life\ time) \]
   - Reliability of systems composed of multiple items: \( R_{sys} = g(R_i); i = 1, \ldots, N \)
     - Logical connections of the components (fault trees, etc.)
     - Reliability block diagrams
   - Common Assumptions
     - Maintenance and repair contribute to the renewal
     - Degradation can be measured by the hazard rate.

2. Physics View: Failures occur due to known underlying failure mechanisms:
   - Accumulate damage until exceeds endurance (i.e., resistance to damage)
   - Performance decline which until a minimum requirement reached
   - Applied stresses (load) exceeds strength (capacity) to resist the applied stress
Thank you for your attention!