Reliability Engineering: A Brief Overview

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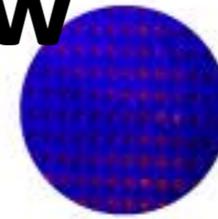
- Reliability engineering measures and improves resistance to failure over time, estimates expended life, and predicts time-to-failure

- 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

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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
    – Design (Assuring Reliability, Testing, Safety, Human-Software-Machine, Warranty)
    – Operation (Repair, Maintenance, Risks, Obsolescence, Root Cause Evaluations)

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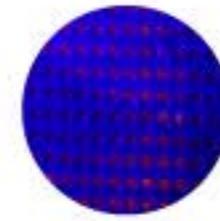
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Data and Physics Views
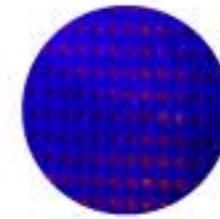
1. Data View: Post WWII Initiatives due to unreliability of electronics and fatigue issues--asserts that historical failure data or reliability test data represent the truth

    - 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: $R_{sys} = g(R_i); i = 1, \dots N$

        – 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!