

OSMA Digital Evolution: R&M Physics of Failure (PoF) Handbook

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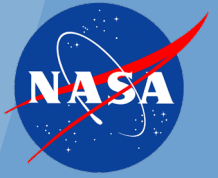
For the PoF Handbook Development Team: Jeff Dawson (GSFC), Nobel Sindjui (GSFC), Doug Sheldon (JPL), Nancy Lindsey (HQ/GSFC), Anthony Diventi (NASA R&M Technical Fellow, and many NASA contributing authors

NEPP Electronics Technology Workshop

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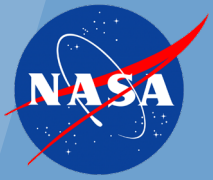


Outline

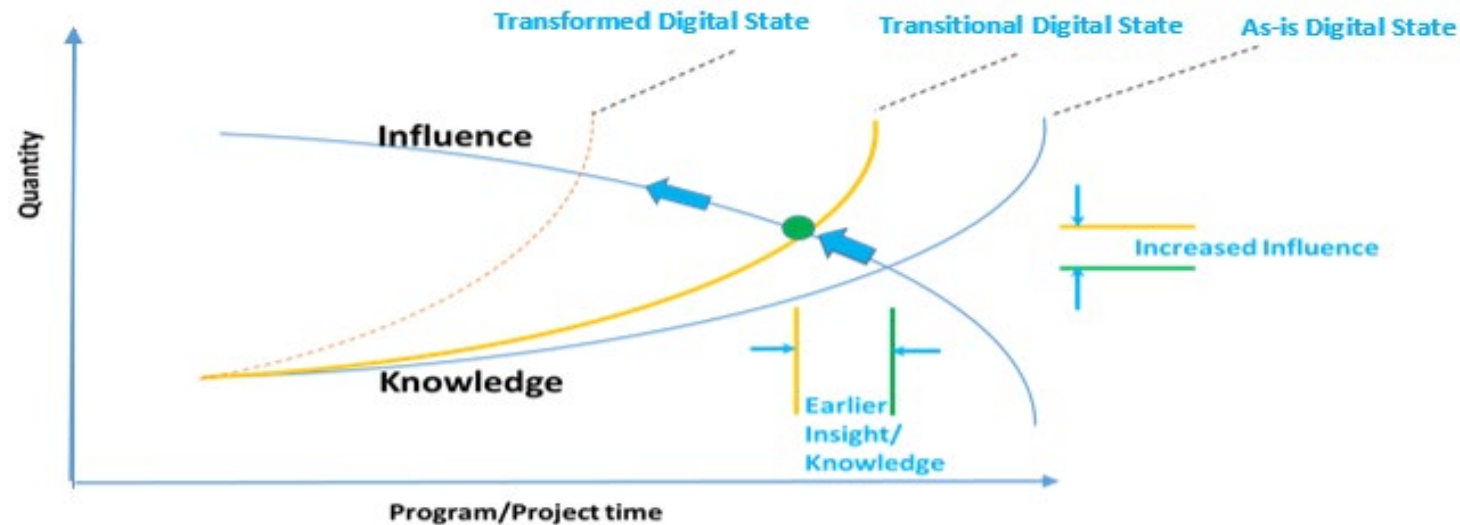


- Motivation
- R&M Digital Evolution Plan
- What is Physics of Failure ?
- Physics of Failure (PoF) Handbook
- How NEPP and other Agency Partners can help
- Questions

Motivation

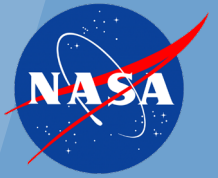


Digital Evolution:



- Streamline the engineering processes and data acquisition/manipulation
- Share data created or collected from other missions and early design phase seamlessly
- Leverage tools and technology throughout NASA.
- Ensure Mission Success through knowledge and influence

R&M Digital Evolution Efforts



Phase1: Discover our Resources and Barriers

- ✓ Conduct Data Survey
- ✓ Communicate Findings
- Solicit Recommendations and Additional Data Sources

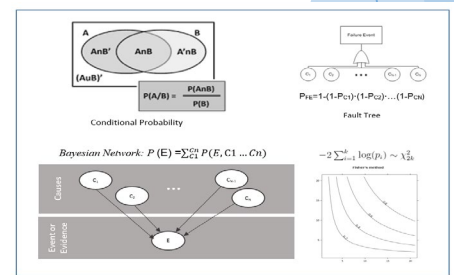
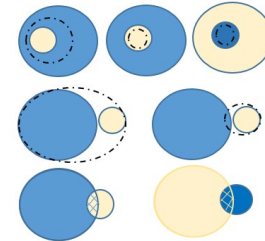
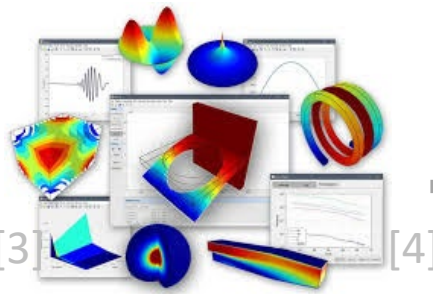
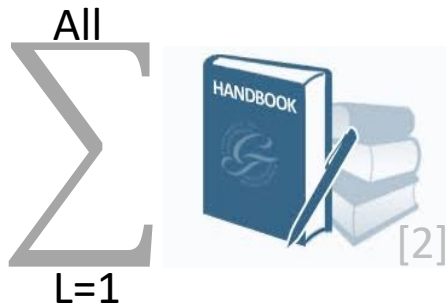
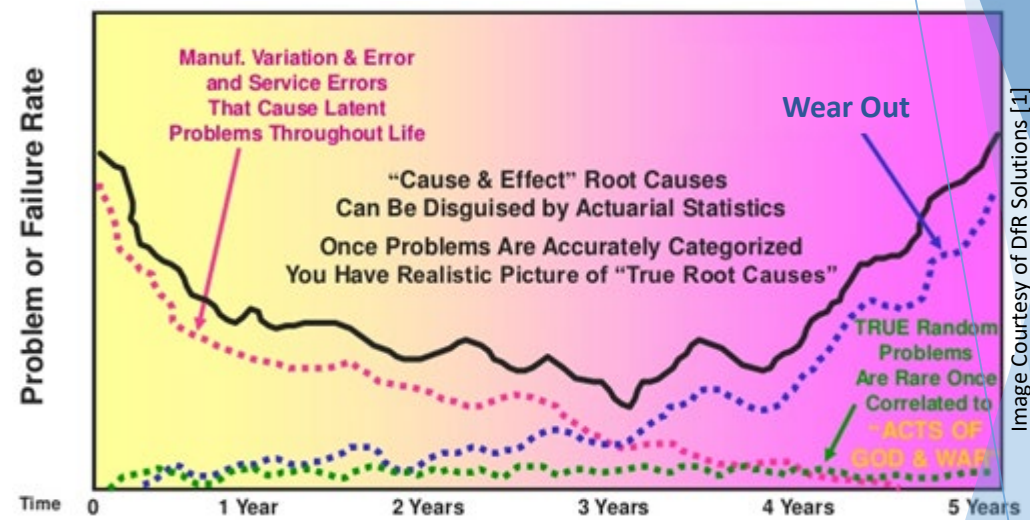
Phase 2: Enable and Advance Transitional Digital State

- Identify Strategies to fill data gaps via FAIR approaches
 - Data Mining for Data Sharing and Modeling Support within R&M
 - Develop and Share practice data on the R&M Knowledge Portal
 - Increase understanding of data needs and sharing with other disciplines
- Identify Strategies to mitigate implementation barriers
 - Data Mining for Data Sharing and Modeling Support
 - Develop and Share the value that can be anticipated from R&M Processes on the R&M Knowledge Portal
 - Increase outreach to engineering disciplines across NASA and beyond
- Identify Strategies to enable greater R&M Efficiency
 - Best Practice and product sharing
 - Model-Based R&M (reference models, libraries, etc.)
 - Physics of Failure

Phase 3: Achieve Digital Transformation

What is Physics of Failure (PoF)?

The development of Root Cause Models that can be combined with Statistical Methods to move assumptions from the bathtub curve to more realistic and complete risk assessments.



(..... Data/Models.....)

(..... Likelihood Relationships and Statistical Fusion Processes.....)

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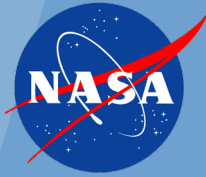


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Federation: Using a single method or multiple methods concurrently with or in lieu of reference rates (e.g., handbook data) to develop system failure likelihood using statistical techniques and considering dependencies of individual findings.

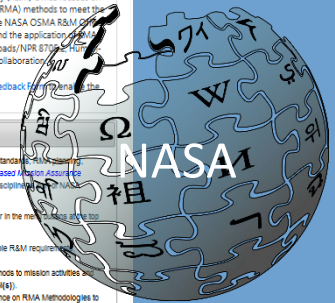
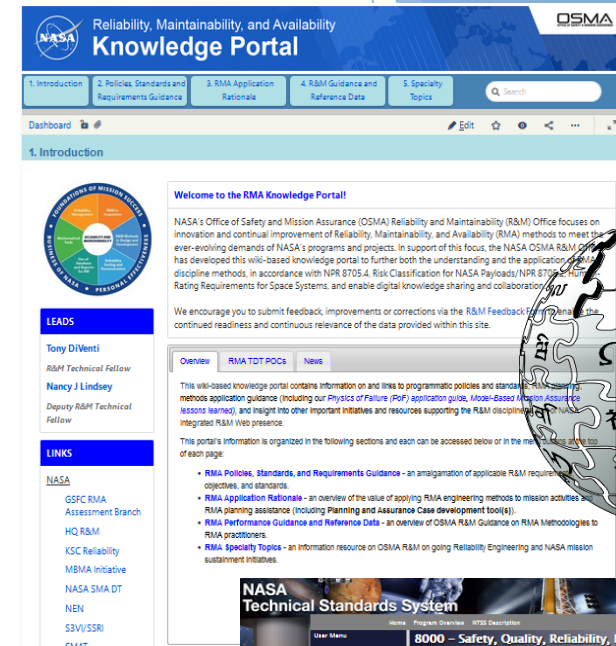
Empirical: Analysis methods that study the failure history of parts under given conditions, then fits the failure data to a probability distribution

- ✓ Statistical Modeling Analysis (Exponential, Weibull, Lognormal, Normal),
- ✓ Bayesian Statistical Inference for Updating Failure Rates,
- ✓ Peck's Temperature-Humidity Relationship Prediction,
- Black's Model for Electro-migration Analysis)

Deterministic: Analysis methods that involve the study of the predicted underlying physical processes/causes that could cause failure and results in a mathematical relationship describing the failure potential:

- ✓ Accelerated Performance Analysis (Arrhenius, Inverse Power, Coffin-Manson, Zhurkov, Palmgren),
- ✓ Eyring Modeling,
- Multiphysics Simulation Analysis (Performance and Variation Modeling (e.g., Nonconformance (PCB, Workmanship, Manufacturing) risk assessment),
- Heat Transfer,
- Fluid (Pipe Flow),
- Electromagnetics (Wave Optics, Ray Optics, AC/DC),
- ✓ Structural Analysis Modeling,
- Acoustics,
- Chemical (Batteries and Fuel Cells, Electrodeposition, Chemical Reactions),
- Electromagnetic Compatibility (EMC) and Signal Integrity Analysis,
- Thermal Fatigue Analysis,
- Life/Wearout Durability (ALT) Modeling,
- Radiation Susceptibility Analysis)

Case Studies



Share!

Document Number	Revision	Document Date	Effective Date
NASA-CS-8710.10	Baseline	2004-09-01	
NASA-HQ-8710.02	Baseline	2010-09-08	8
NASA-HQ-8710.24	Baseline	2011-11-09	1
NASA-HQ-8710.14	Baseline	2008-07-02	1
NASA-HQ-8710.10	Baseline	2008-04-29	
NASA-HQ-8710.10-2	Baseline	2010-07-16	
NASA-HQ-8710.10-3	Baseline	2010-07-16	
NASA-HQ-8710.10-4	Baseline	2010-07-16	
NASA-HQ-8710.21	Baseline	2011-09-18	
NASA-HQ-8710.22	A	2010-09-02	
NASA-STD-8710.00	Baseline	2010-09-09	1
NASA-STD-8710.11	E	2000-09-02	1
NASA-STD-8710.12	A	2010-09-09	2
NASA-STD-8710.14	E	2010-04-05	
NASA-STD-8710.17	C	2017-09-09	2
NASA-STD-8710.24	Baseline	2011-09-09	2
NASA-STD-8710.24-ANNEX	A	2010-09-02	2
NASA-STD-8710.0	E	2010-10-03	

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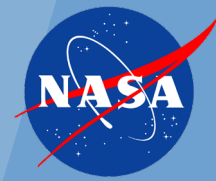


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Authors Sought for the following sections:

- 3.2 Multi-physics Simulation Analysis (Performance and Variation Modeling (e.g., Nonconformance risk assessment))
- 3.2.2 Fluid (Pipe Flow)
- 3.2.3 Electromagnetics (Wave Optics, Ray Optics, AC/DC)
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Case Studies Sought: Any/All



Questions