VITA 51 Overview

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Topics

- **History, Background**
  - History of Reliability Predictions
  - NSWC Crane Study, 2004
- **VITA 51**
  - Who is VITA?
  - VITA 51 Working Group
  - VITA 51 Documents
- **ANSI/VITA 51.0-2008**
- **ANSI/VITA 51.1-2008**
- **ANSI/VITA 51.2-2011**
- **Summary, Further Info**

History of Reliability Predictions

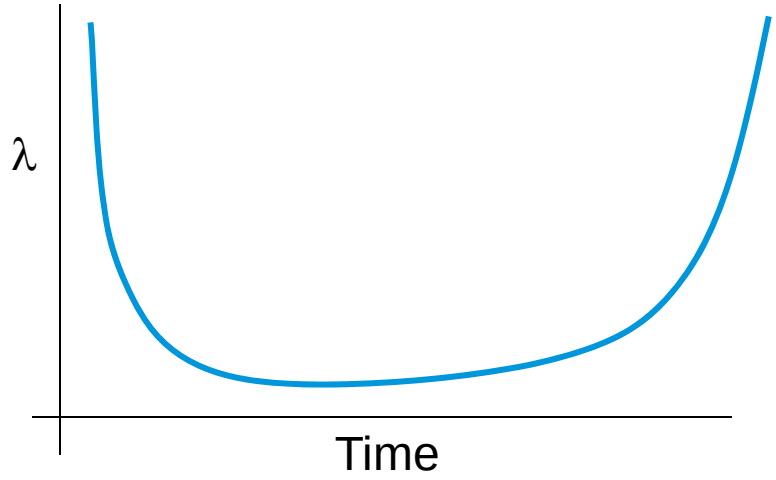
- In the Defense and Aerospace Industry, Reliability Predictions of Circuit Card Assemblies (CCAs) are used to support Trade Studies, Logistic support models and maintenance planning
- Through the analysis of historical failure data, mathematical models were derived for determining component failure rates

1961 – Failure rate models for electronic components and the process for using them were defined in MIL-HDBK-217

The tool became the standard for Reliability Engineering

1994 – U.S. Secretary of Defense issues memorandum on "Specifications & Standards - A New Way of Doing Business"

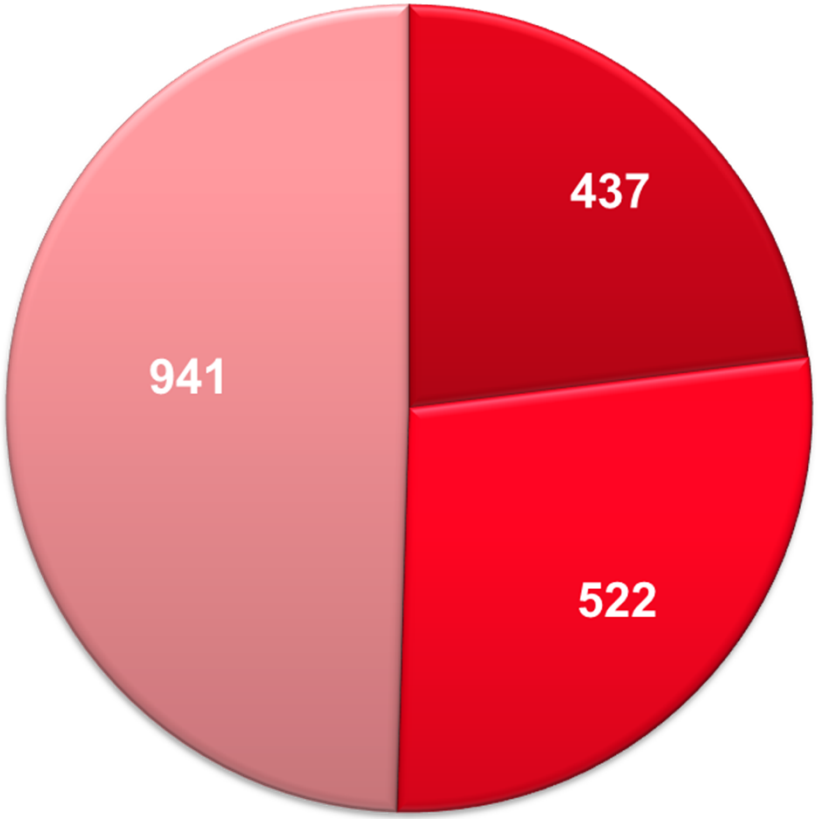
MIL-HDBK-217 has not been updated since 1995 (most ICs since 1991)



NSWC Crane Study, 2004

- **Study initiated in 2004**
  - Naval Surface Warfare Center (NSWC) Crane was tasked by the Defense Standardization Program Office (DSPO) to assess the "Feasibility of Standardizing COTS Module Reliability Predictions"
- **2 Surveys conducted**
  - How many modules have Traceable data (MTBF)?
  - What tools are being used to generate MTBF data?

Traceable MTBF Survey



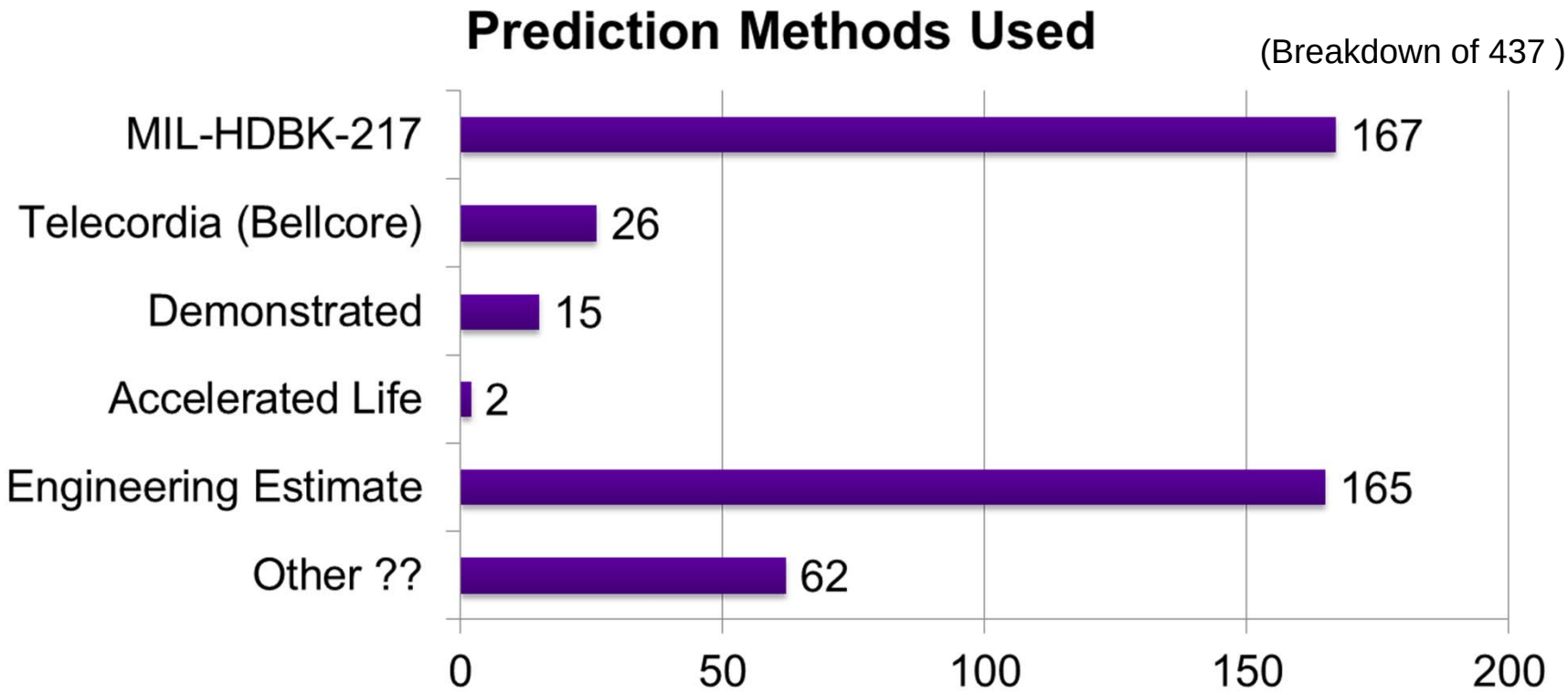
1900 COTS Items

(1378 with MTBF)

- Traceable MTBF *
- No MTBF Reported
- Not Traceable MTBF Source

*** Less than 25% of items surveyed had published and traceable MTBF numbers!**

Results of NSWC Crane survey



MIL-HDBK-217 Telecordia (Bellcore)
Demonstrated Accelerated Life

210

Engineering Estimates
Other ??

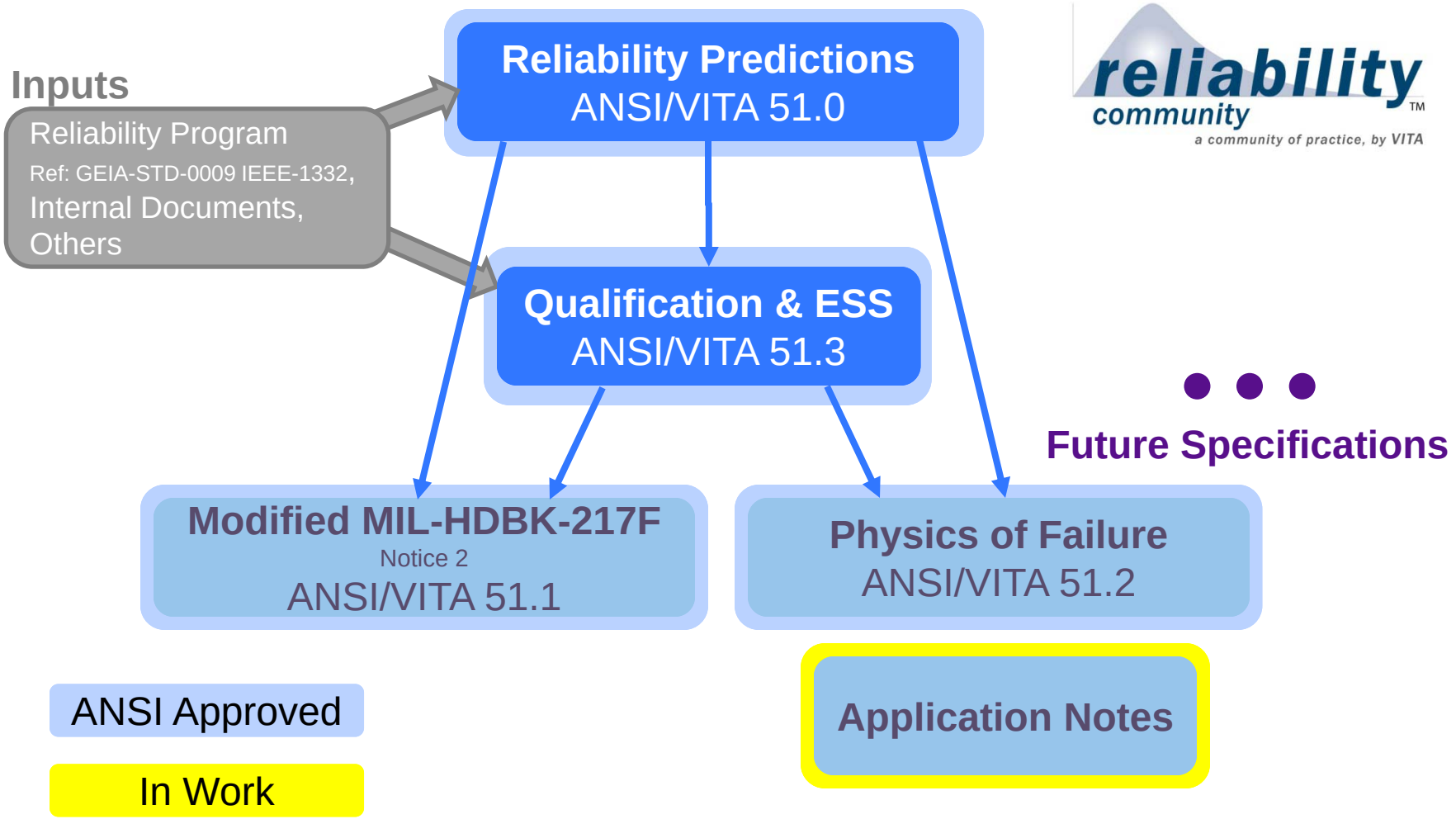
227

- **VITA** **(Formerly VMEbus International Trade Association)**
  - Incorporated, non-profit organization of vendors and users having a common market interest
  - Founded in 1984, VITA believes in and champions open system architectures as opposed to proprietary system architectures
  - VITA's activities are international in scope
  - VITA's mission includes not only promoting VMEbus, but promoting the very concept of open technology as embodied in the many standards currently under development within the VITA Standards Organization
  - VSO (VITA Standards Organization) is accredited as an American National Standards developer and a submitter of Industry Trade Agreements to the IEC

VITA 51 – Reliability Working Group

- **Founded in November, 2004, at the request of NSWC Crane**
  - Sponsored by NSWC Crane, Boeing, Curtiss-Wright Controls
- **Initial efforts focused on MIL-HDBK-217**
  - Provide practitioners of MIL-HDBK-217F with an industry consensus based approach to MTBF calculation
  - Published ANSI/VITA 51.1-2008 - provides defaults and common modification factors for MIL-HDBK-217F Notice 2
  - Provided information for MIL-HDBK-217 Rev G
- **VITA 51 continued advancing reliability prediction methods**
  - Physics of Failure
    - Published ANSI/VITA 51.2-2011
  - Tied into AVSI Reliability Roadmap
  - VITA 51 Marketing
    - www.vita.com/home/MarketingAlliances/Reliability/reliability.html

Roadmap of VITA 51 Reliability Specifications



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ANSI/VITA 51.0-2008 Summary

- **Base Specification – Framework for predictions**
- **Provides background information on reliability prediction methodologies**
- **Establishes ground rules for subsidiary specifications**
- **Requires use of a disclosure statement to document modeling assumptions, defaults, exceptions to the methodologies used**
- **Establishes a Community of Practice**

Contents of ANSI/VITA 51.0-2008

reliability community™
a community of practice, by VITA

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ANSI/VITA 51.1-2008 Summary

- **Provides default parameters for MIL-HDBK-217F Notice 2**
  - Is not a replacement for MIL-HDBK-217F Notice 2
  - Not all component families from MIL-HDBK-217 are covered
- **Changes PiQ for commercial quality components**
  - Originally PiQ=10, changed to PiQ=1 for many components
- **Includes references to sources**
  - Field and test data used for resistor and capacitor factors
  - Uses “engineering judgment” as source for some factors
  - All source data was provided to NSWC Crane and used in the MIL-HDBK-217 Rev G effort

Contents of ANSI/VITA 51.1-2008

MIL-HDBK-217 Revision Efforts

- **Industry working group led by NSWC Crane,**
  - Started May 2008, just as VITA 51.1 effort concluded
  - Data from VITA 51 re-used
  - All data kept and managed by RiAC
- **May 2010 - Draft Rev G released by Navy for public review, but quickly retracted**
  - Internal DoD discussions about reliability policy
- **DoD Policy published in Directive-Type Memorandum (DTM) 11-003, March 21, 2011**
  - Implementation Guidelines in work
- **Due to similarity with Rev G, some electronics suppliers are using ANSI/VITA 51.1-2008**
- **October 2011 – Renewed DoD interest in MIL-HDBK-217 revisions, especially to include use of PoF methods**

ANSI/VITA 51.2-2011 Summary

- **Physics of Failure (PoF) Reliability Prediction**
  - Fatigue mechanisms
  - Models based on physical properties of material
- **Provides uniform practices for VITA members**
  - Board level, packaging and component models
  - Guidelines for PoF program planning
- **Takes advantage of current industry development**
  - Research results and expertise from AVSI, AMSAA, CALCE, DfR Solutions
  - Includes Pb-free solder fatigue
- **Clarifies expectations for reliability prediction providers and customers**

ANSI/VITA 51.2-2011 provides a open system industry standard approach for physics of failure modeling of electronic modules

Definitions

- ***Failure Mechanism*: the physical processes by which a combination of thermal, mechanical, electrical, chemical and magnetic stresses damage the materials comprising the product**

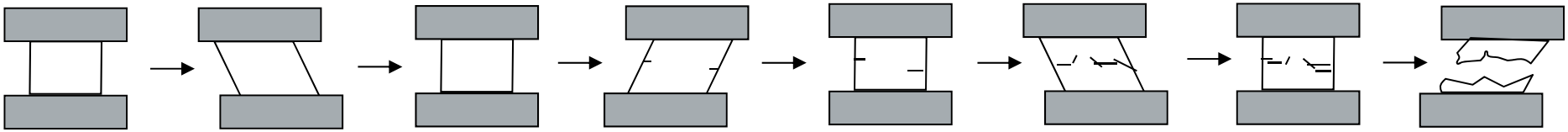
- ***Failure Mode*: a physically observable change caused by a failure mechanism**

- ***Failure Cause*: the circumstances during design, manufacturing, or use which have induced or activated a failure mechanism**

- ***Failure Site*: the location of a failure mechanism**

Fatigue

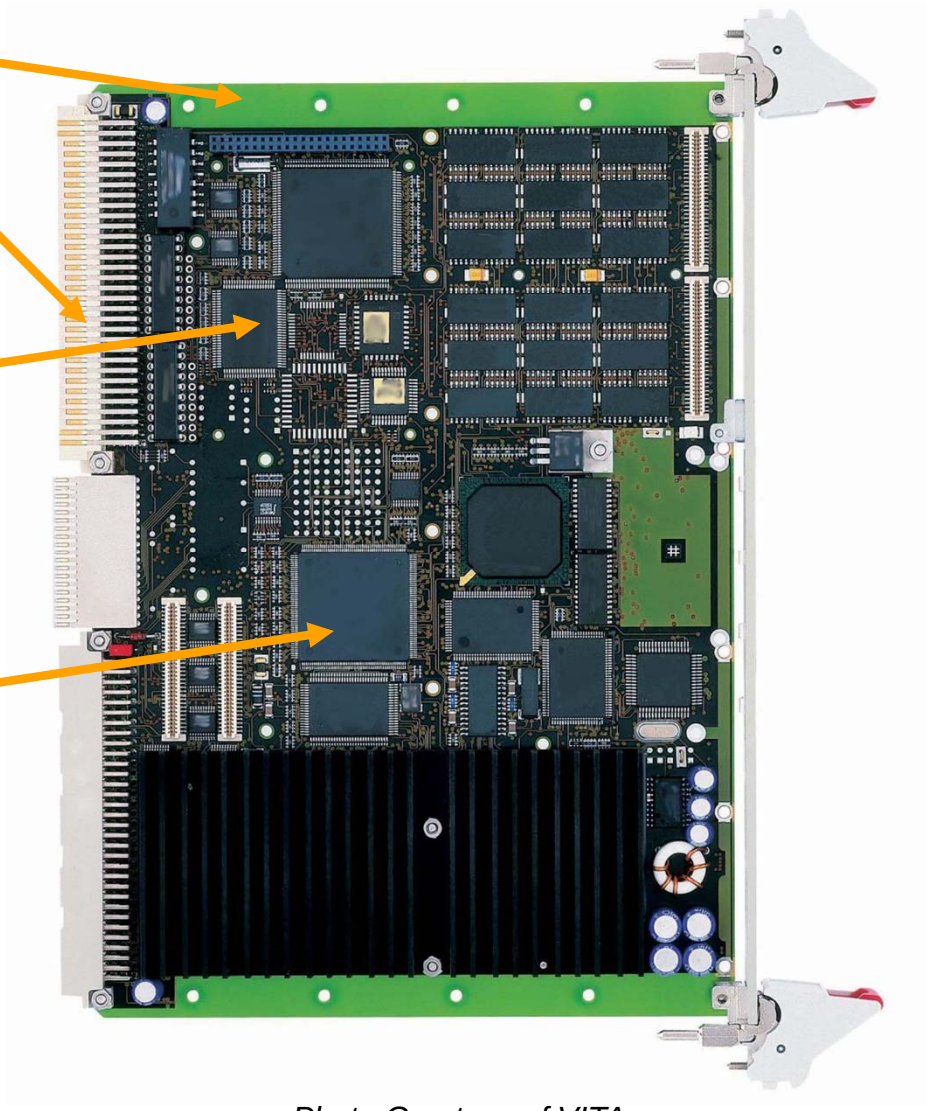
- **Fatigue occurs when stress is applied repeatedly**
- **Material under stress flexes, deforms and weakens (strains) until a fracture occurs**



- **Physics of failure (PoF) based reliability is expressed as a "time to failure" or "cycles to failure" where "cycles" are repetitions of fatigue stress applications**

ANSI/VITA 51.2-2011 Organization

- **Board Level Mechanisms**
  - Cumulative fatigue, Miner's rule
  - Vibration
  - Thermal Cycling
  - Shock
  - Electrochemical migration
- **Packaging Mechanisms**
  - Vibration
  - Thermal Cycling
  - Whisker formation
  - Corrosion
- **Component Mechanisms**
  - Electromigration
  - Time-dependent dielectric breakdown
  - Negative bias temperature instability
  - Hot carrier injection
  - Atmospheric Radiation
  - Corrosion



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ANSI/VITA 51.2-2011 PoF Planning

- **PoF Implementation Plan should include:**
  1. Failure mechanisms to be included, based upon previous experience with similar equipment or manufacturing processes
  2. Failure models selected for those failure mechanisms
  3. Model parameters to be used
  4. Process under which the analysis is to be performed

- **Selection of PoF models depends on:**
  - Intended application of the electronics
  - Customer/user requirements and constraints
  - Intended usage environments
  - Resources available to perform the PoF analysis
  - Economic considerations of the outcome – e.g. cost of failure, warrantees, liability, public image

Summary, Further Info:

- **VITA 51 Reliability Marketing Alliance:**
  - www.vita.com/home/MarketingAlliances/Reliability/reliability.html
  - Includes News, FAQ, Articles, Links
- **IEEE RAMS Conference Proceedings, 2010 and 2011:**
  - Harms, J. "Revision of MIL-HDBK-217, Reliability Prediction of Electronic Equipment" IEEE RAMS 2010
  - Bechtold, L. "Industry Consensus Approach to Physics of Failure in Reliability Prediction" IEEE RAMS 2010
  - Bechtold, L. "Reliability Predictions to Support a Design For Reliability Program" IEEE RAMS 2011