Ammunition Stockpile and Service-life Reliability: *Improvement Efforts at US Army ARDEC*

Presented for Precision Strike Association Firepower Forum

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The Problem

- Testing for reliability through the life of a smart-munition is not financially feasible
  - Firing 100+ rounds from each strata
  - Every 3-5 years
  - For the life of the item
- Waiting until the item is bad does not provide enough time to buy more
  - 2 to 6 year cycle time from need to field

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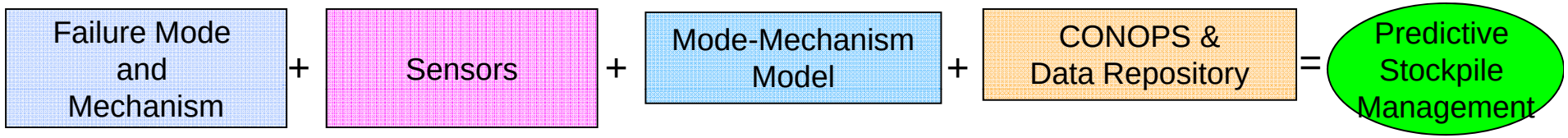
The Solution: Predictive Stockpile Management



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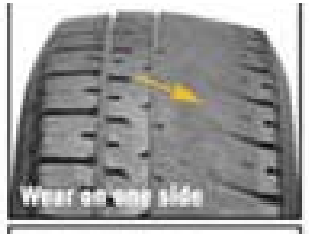
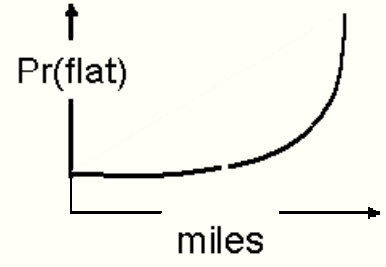
An Example…

- Identify Failure Mode
  - What fails?
- Identify Failure Mechanism
  - What causes the failure?
- Determine rate of degradation
  - How long does it take to fail?
- Correlate and synthesize
  - When will it fail?
  - When should I produce more?
  - Which items are at risk?
  - Which items are not?

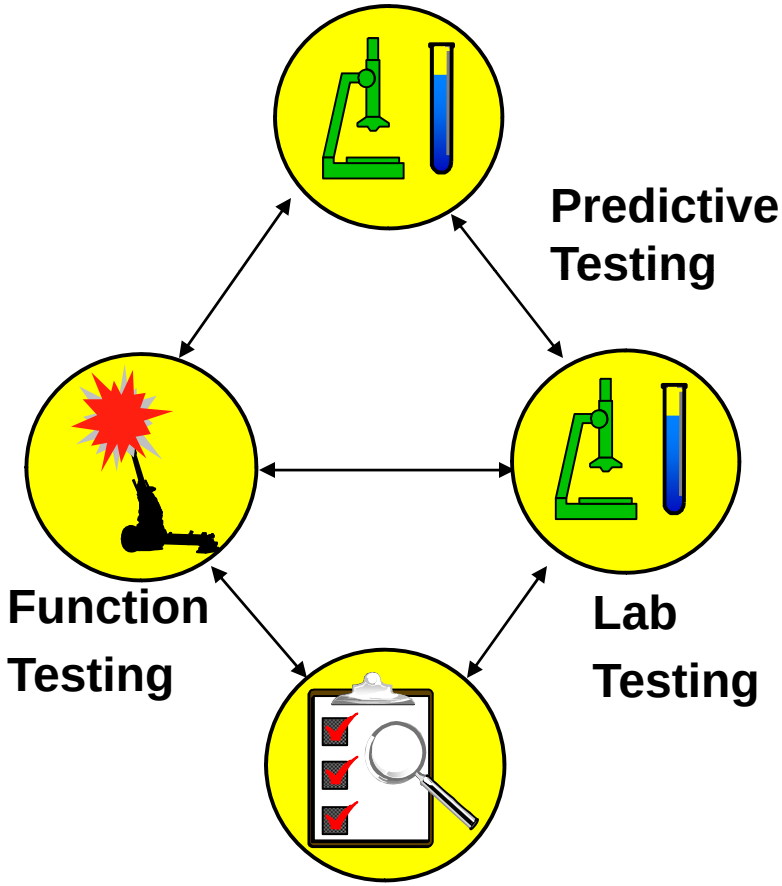




Ammunition Stockpile Reliability Program

Elements of the ASRP:

- ✓ Design for Storage Life
  - ✓ Predictive Engineering
- ✓ Ammunition Surveillance Program
- ✓ Function (Reliability) Testing
- ✓ Laboratory testing program



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Storage Life Predictions

- Proactive (Development Items)
  - Analogy based analysis to determine at risk, life limiting items
  - Accelerated life testing to predict storage life
    - Controlled
    - Uncontrolled
  - Determine design changes or mitigations to extend life

- Reactive (Fielded Items)
  - Perform function testing per ASRP Plan
  - Analysis of variance
    - Age
    - Lot
    - Manufacturer
    - Storage location/type
    - Design revisions
  - Detect reliability degradation trends
  - Predict breach of lower reliability threshold

Predictive Technology (ALT) can be used for fielded items also

Initiatives

- Policy – Army Regulations and local installation application policies
- Process – Lean Six Sigma Green Belt Project to refine methods
- Data - Predictive Summary Report and Benchmarking
- Application – Synergistic programs addressing multiple items or classes of items

Goal – Enable Predictive Stockpile Management

ASRP Policy

- Memo documenting policy requirements
  - Ammunition Stockpile Reliability Program
    - AR 702-6
  - Ammunition Surveillance
    - AR 740–1, AR 702–12, and AR 700-142
  - Required at time of MR
- Key responsibilities of PM and ARDEC
  - Baseline performance and reliability
  - Identify life-limiting components
  - Identify acceptable limits of degradation
  - Design and build unique inspection/test equipment

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SSGB Project

- Objectives:
  - Develop process map for creation of ASRP Plan
  - Improve timeliness and value of the ASRP Plan and its execution
    - Completed at time of MR
  - Improve quality of plans to include:
    - Greater use of predictive engineering and accelerated life testing
    - More item and failure mode unique testing and inspections
    - Add Ammunition Peculiar Testing Equipment
    - Add detailed test procedures
  - Institute Configuration Management
    - Approval routing
    - Revision Management
    - Document Maintenance
    - Define how ECP and MIF information is added to ASRP Plan

- Approach:
  - Define current process
  - Measure and Analyze results of current process and adherence to AR
  - Improve and Lean process to provide more value and synergy across ammo classes
  - Institute Controls to ensure continual improvement

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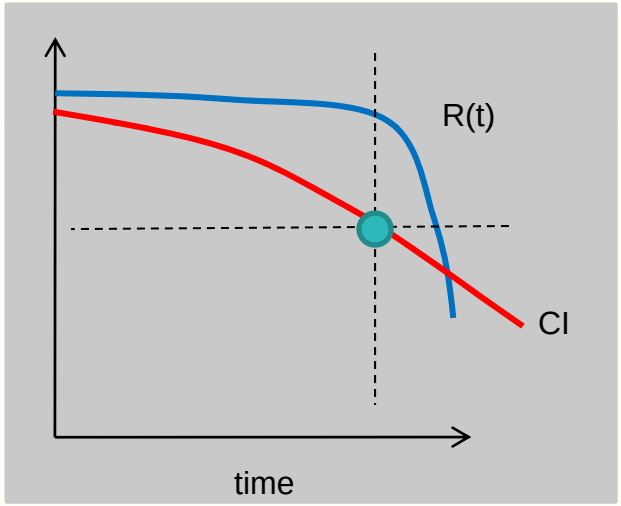
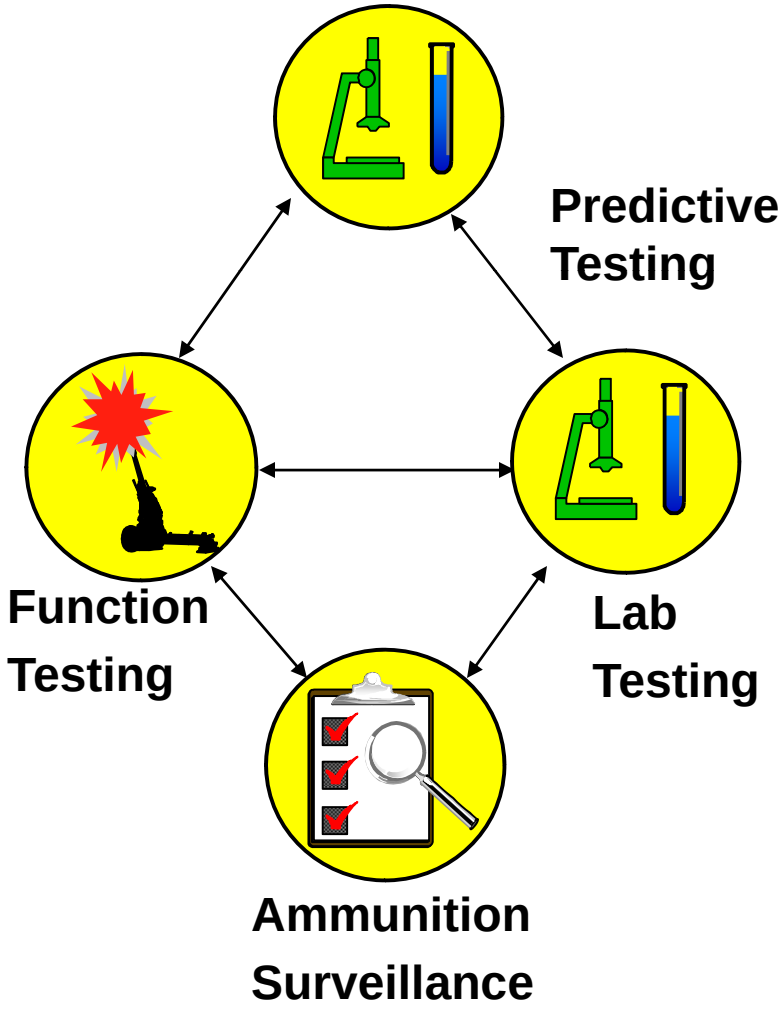
Unified ASRP Approach





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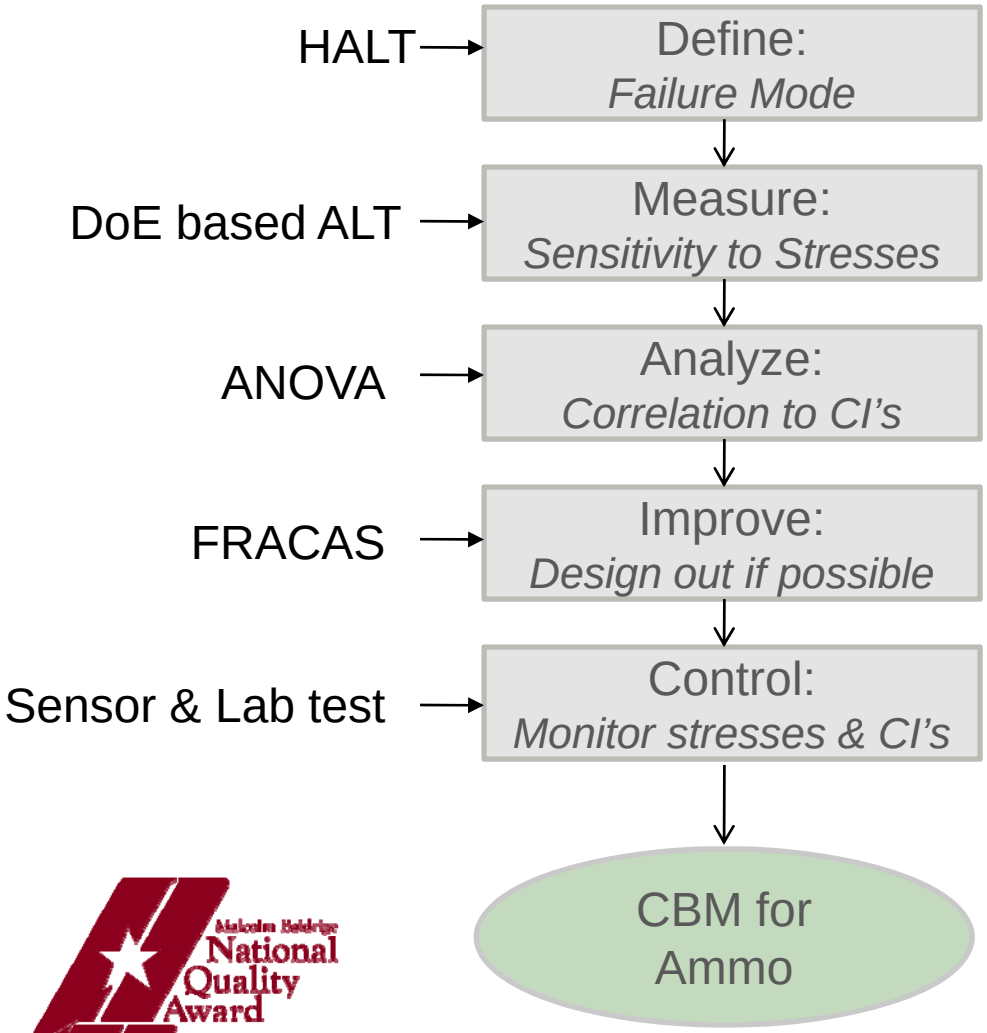
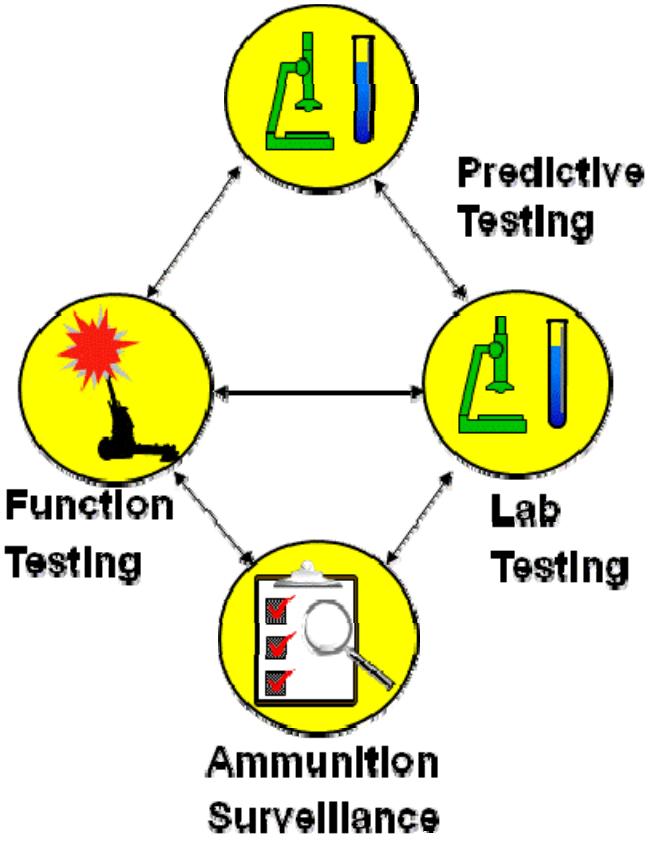
Practical ALT





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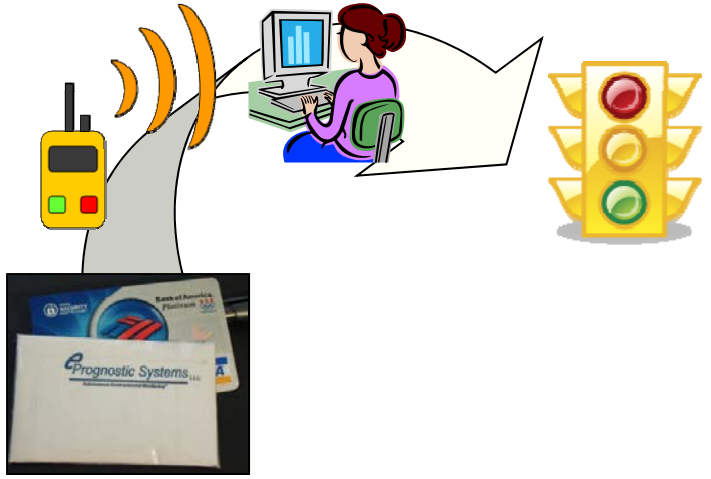
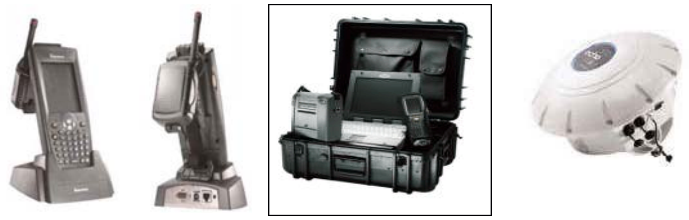
Predictive Summary Report

- Compilation and update of tests and analyses capturing environmentally susceptible items and components
- Sources:
  - ASRP function testing
  - ASRP surveillance inspections
  - DIF/MIF reports
  - FAT/LAT results
  - Predictive Engineering/Aging Studies
- Motivation
  - Identify common causes and risk for LCMC managed items
  - Provide repository of data to expedite MR process and avoid duplication of effort
  - Determine candidates for further investment and investigation
    - Aging program
    - In-situ sensing
    - Telemetry
    - Additional functional, lab, or surveillance sampling

Sensor and Database Project

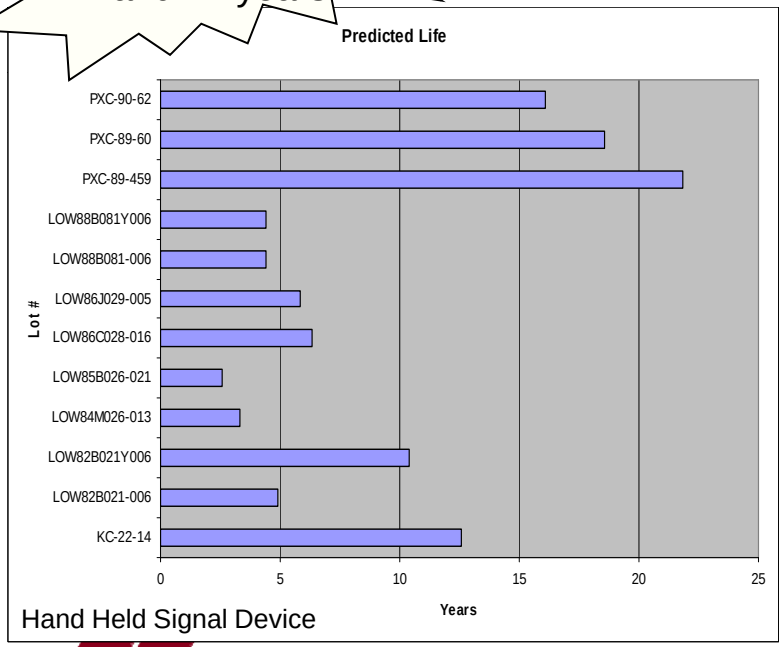
- Investigate COTS sensors
  - Literature review and continued work with UMD Consortium
  - Identify customer requirements (cost, size, IO, resolution)
  - Classes of sensors
    - Cheap and simple for cheap and simple
    - Ensure CBA/ROI is favorable
- Qualify one or more from each class
  - Durability - Sensor can't fail before round
  - Accuracy – Sensor data can't drift with time
  - Interoperability(E3) – Eliminate interference/safety concerns
- Data Analysis and Warehouse
  - Open Architecture
  - Tailorable
  - Self-definable models
- Application guidance
  - Common I/O and data collection methods
  - Coordination with JMC QASAS



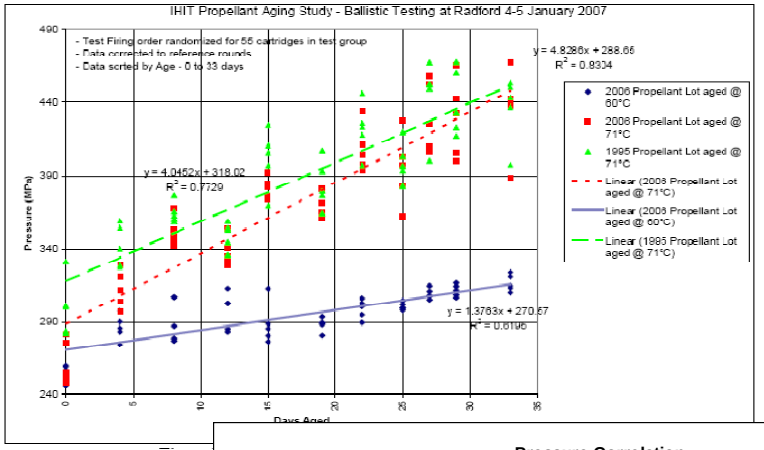


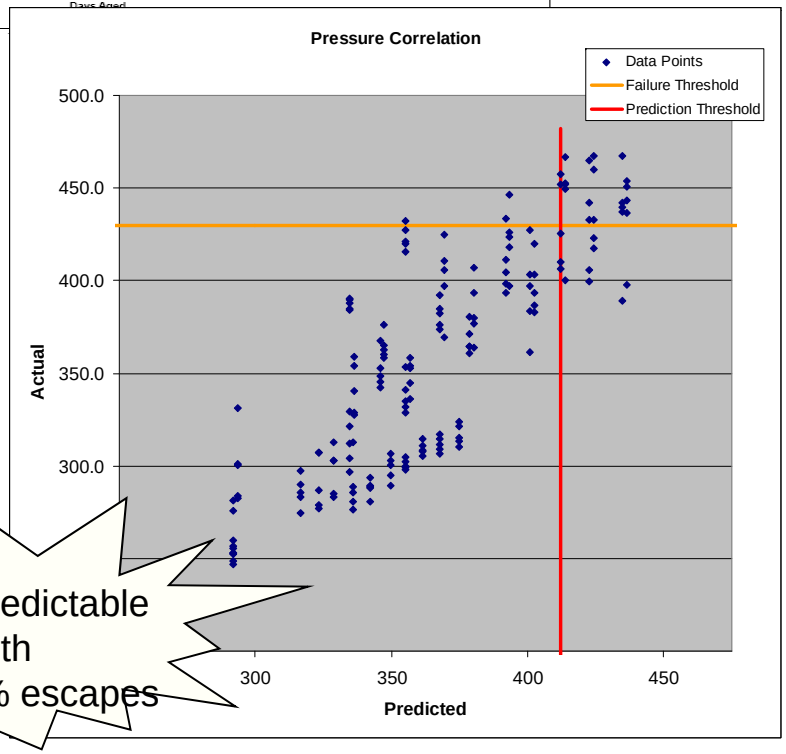
Value of Temperature Data

Life Estimate between 2 and 22 years



Hand Held Signal Device





Failure Predictable with Only 1.7% escapes

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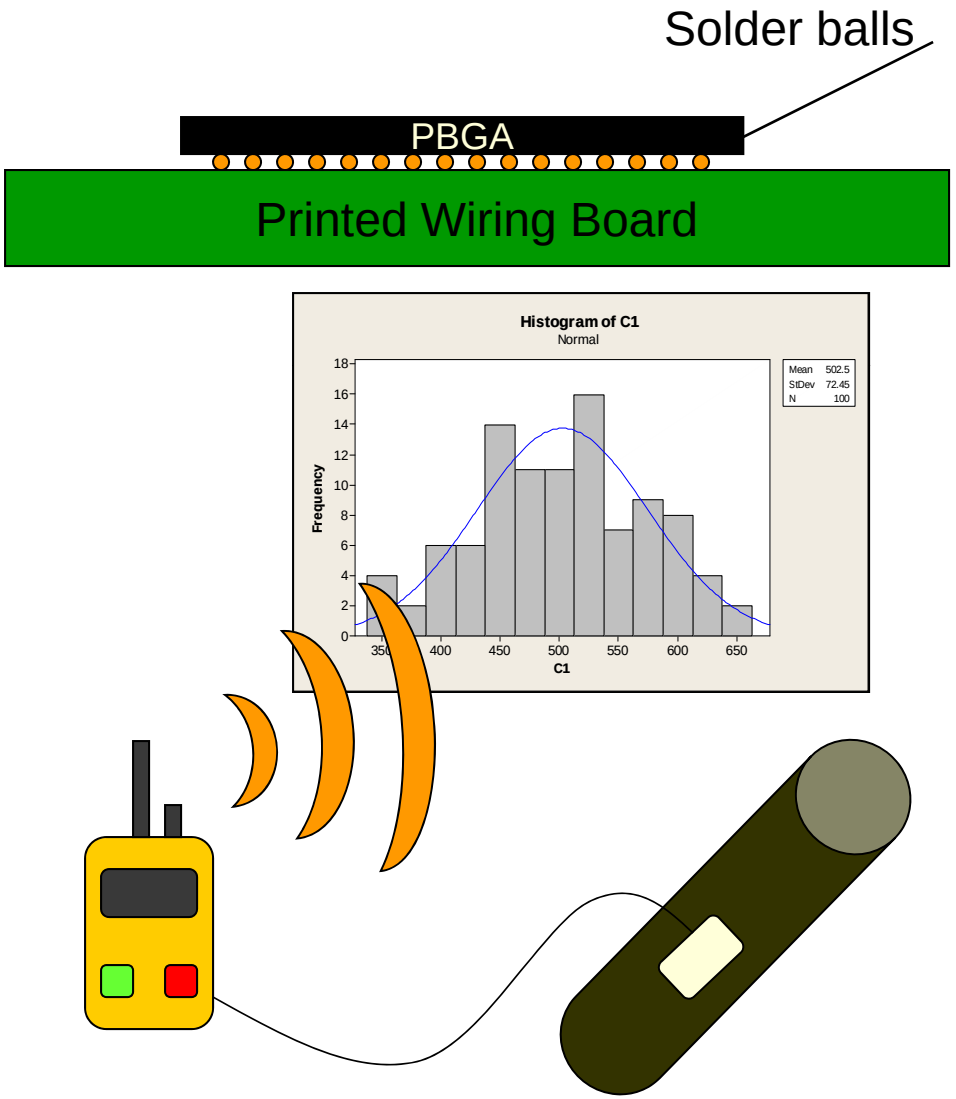
Electronics Predictive Project

- Reliability Characterization of SMT components in temperature cycling environment
- Predictive algorithm development to identify incipient failures
- Demonstration sensor(s) from Low Cost sensor program (if funded)



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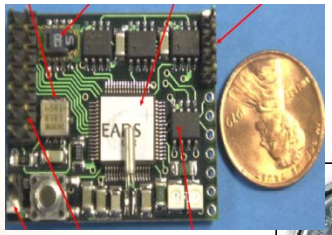
Predictive Stockpile Mgmt. Roadmap

PSES

Low Cost Sensors

PE Summary

SMT Predictive Program



Failure Mode and Mechanism + Sensors + Mode - Mechanism Model + CONOPS & Data Repository = Predictive Stockpile Management

ASRP GB Project

PE Summary Report

PEO ALRD Sensor Program

TCG

Natick

PEO ALRD SMT Project

PE Programs

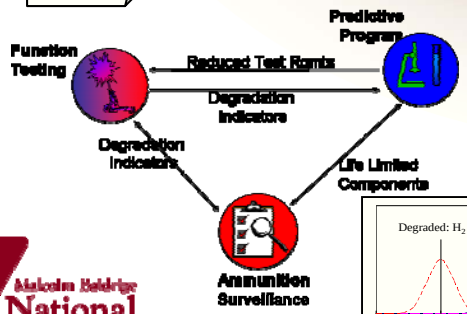
ASRP Data-mining

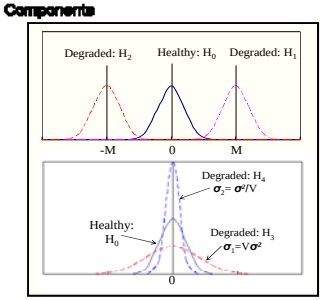
PSES

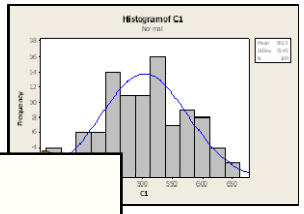
ASRP Online

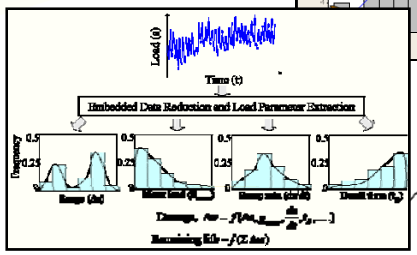
MHP

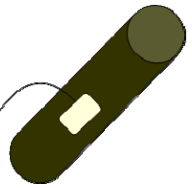
ODS











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Questions?


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