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Prognostics & Health Management (PHM) Center of Excellence (COE)

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.

DECEMBER 2004 ADVISORY BOARD MTG

PHM Center of Excellence

PROGNOSTICS & HEALTH MGMT.

Purpose:

- Assess Technology Community Interest in PHM COE
- Critique a Strawman Organization Concept
- Flush Out Concerns and Issues
- First Step in Securing Support ($)

Scope:

- ~40 Government and Industry Participants
- 3 Day Workshop Format
  - Sandia, government, & industry technology / requirements briefs
  - Open discussion on COE organization, facilities, funding
  - Defined issues, i.e., proprietary technology / transfer

Conclusions:

- There Is a Need
- There Is Enough Interest to Proceed
- Sandia Needs to Build the Concept up One More Level of Detail

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Why a PHM Center of Excellence?

- **PHM is a difficult and widely shared challenge needing the combined efforts of both industry & government**
  - **Across-the-board DoD requirement for PHM/CBM+**
- **Need for a Technology Ground Truth Facility**
  - **Prognostics data library (“Information broker”)**
    - **PHM standards, tools, “who’s doing what”, etc.**
  - **Technology test and validation**
    - **New technologies to the established PHM standards**
    - **One-stop service – technologies, testing, and applications**
  - **Modeling & Simulation**
    - **Complementary analog of the test & validation facility**

The PHM COE Scope:

PHM Center of Excellence

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PHM Technology Development & Validation Center

- **Prognostics Data Library**
  - An infrastructure to collect and store sensor data
  - A warehouse for integration with related data such as materials, maintenance, aging, or other test data
  - Tools to view, analyze, and make predictions
  - Facilitate “lessons learned” feedback to government and industry
- **Technology Test and Validation Facility**
  - Alpha / Beta Test Facility for Sensors, Algorithms, Diagnostic and Prognostic Techniques
  - Machinery system test facility
  - Fluid diagnostics and prognostics test facility - oil debris and hydraulic fluid particle analysis
  - Structural diagnostics and prognostics system test facility
  - Electrical and electronic systems diagnostics and prognostics test facility
- **Prognostics Modeling & Simulation**
  - Emerging M&S capabilities: cost effectiveness, performance, etc.

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How the PHM COE will Operate:

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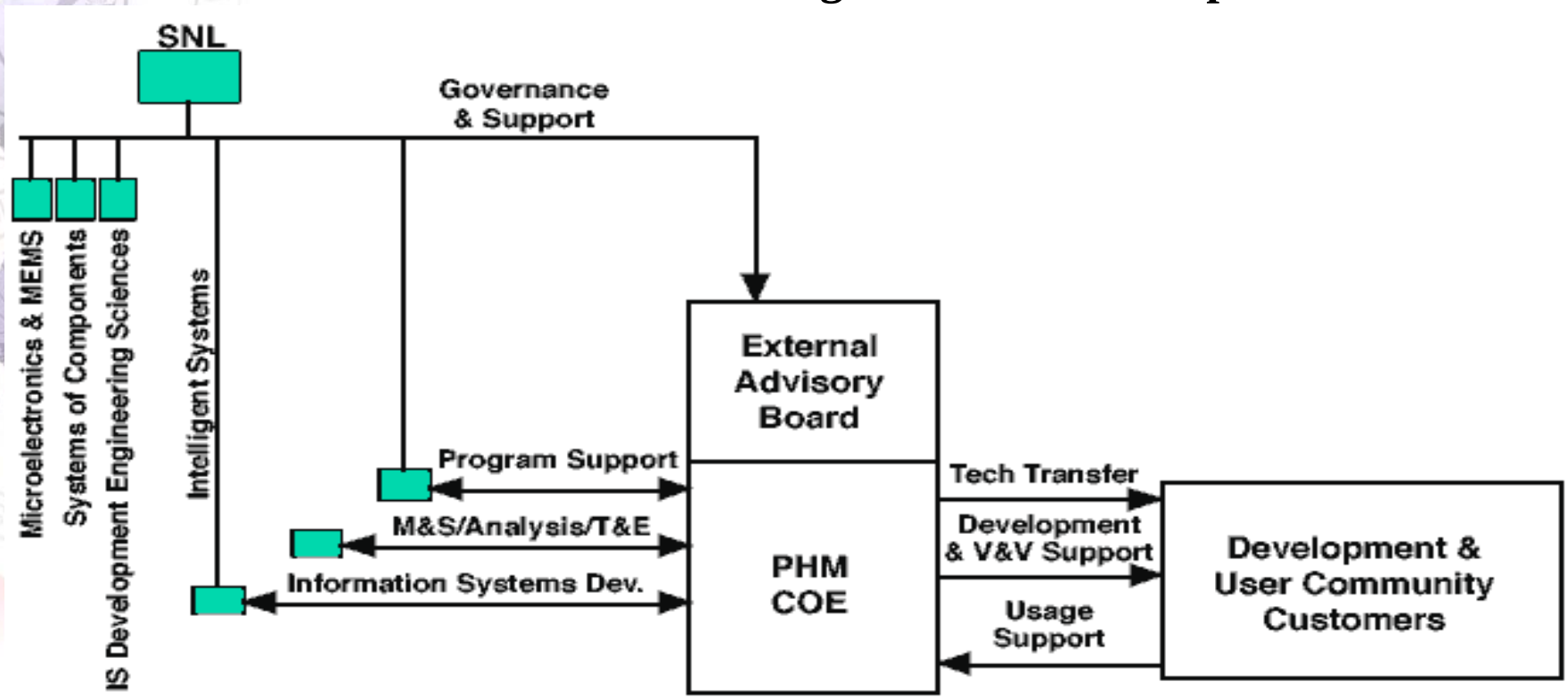
An advisory board will be established and will be composed from organizations within Sandia and external organizations from government, military, industry, academia, and professional societies with specific interest in prognostic and diagnostic technology.

Notional COE Organizational Concept



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Why Sandia?

Sandia has Two Primary Advantages and Discriminators as the Operator of a PHM Technology Development and Validation Center:

1. **One-Stop Service**
   - R&D organization that can address/integrate PHM technologies
     - Machinery
     - Structures
     - Electronics
     - Data
     - Sensors
     - Algorithms

Sandia's Nuclear Weapons Enhanced Surveillance & Life Extension and National Defense programs

2. **Honest Broker**
   - Non-competitive with US industry
   - Accessible to PHM technology users and developers
   - Motivations are US national security and economic competitiveness vs. corporate profit

Sandia's mission is to deliver technology solutions for the most challenging problems that threaten our nation's security and economic competitiveness

Sandia Facilities Support Experimentation & Validation

PHM Center of Excellence

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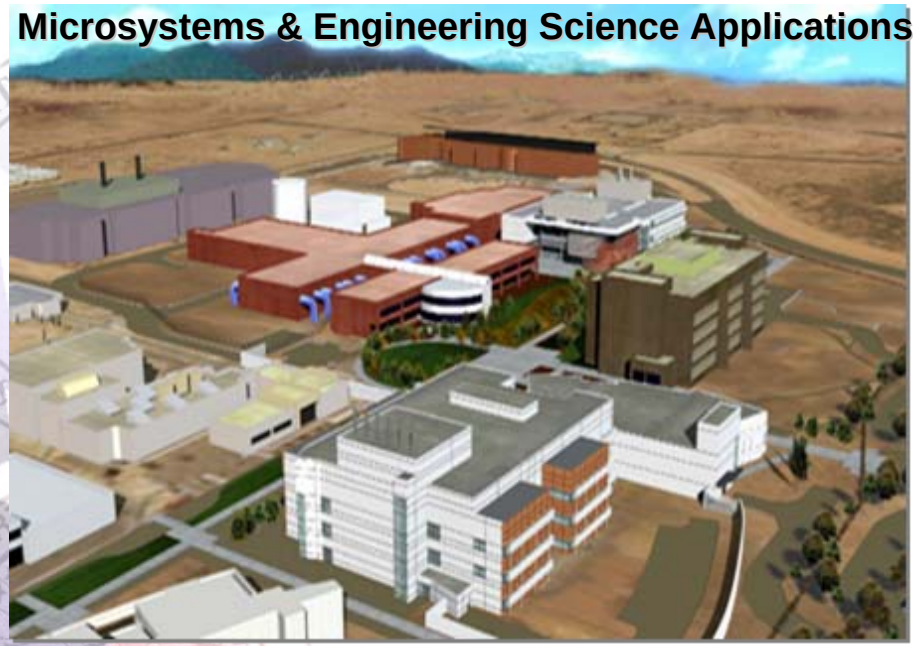
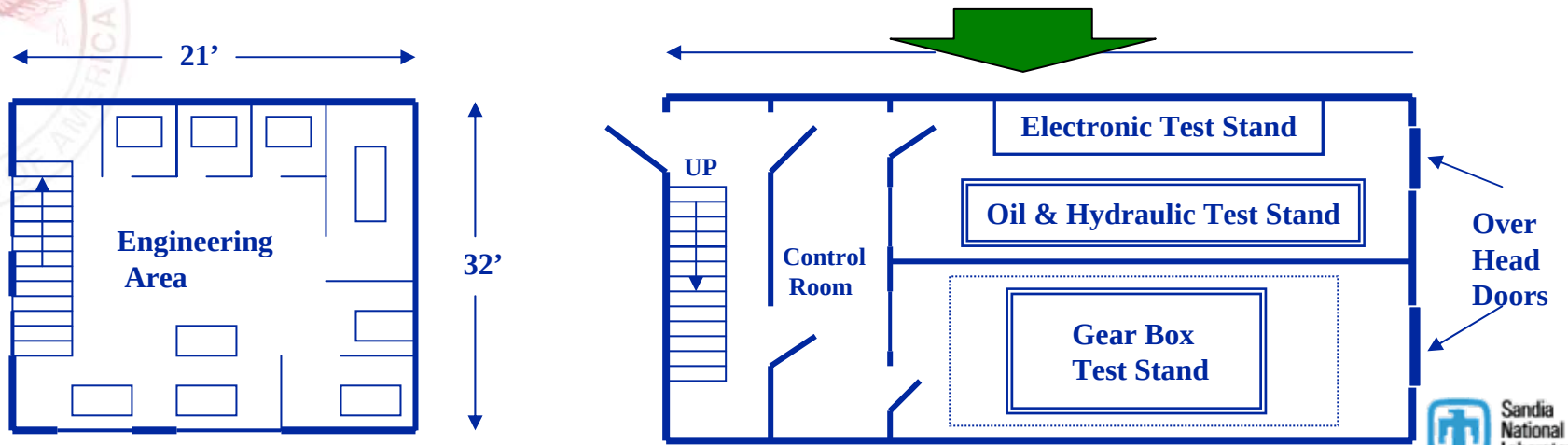


"MESA will provide essential facilities & equipment to enable the design, integration, and qualification of micro-system components and subsystems"

The MESA Complex will be completed in 2008 and will house 648 researchers in 391,000 square feet of space

Proposed PHM COE facility



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Status

- **Sandia Management:**
  - Laboratory and engineering space in MESA facility promised
  - Significant external support necessary to guarantee long-term success
- **Recent Developments:**
  - Meetings with the Honorable Claude Bolton, ASA(ALT)
    - Supports concept of PHM/CBM+ COE for Army
    - Tasked to brief new G-4, LTG Dunwoody
  - Meeting with Mr. Paul Bogosian, PEO Army Aviation
    - "Keen on COE concept"
    - Tasked to provide white paper to obtain '08 POM support
    - Indicated that Dr. Killion's support would be needed
  - Meeting with Dr. Thomas Killion, Deputy Assistant Secretary of Army for R&T
    - Transition path is needed
    - Mission needs to be defined, who are players, what is business model
  - Working with OSD (Ken Krieg, USD (ATL)) on concept of Ops Analysis Center (OAC)
    - Integrates PHM COE

Backup

SNL PHM Activities/Programs

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Power Plant

•Nuclear Power Plant

- Nuclear Energy Research Initiative (NERI), joint program with Penn State, MIT, Duke Engineering, & Westinghouse
- Introduce PHM to selected power plant equipment

AH-64

•Avionics

- Internal laboratory research
- Evaluate data from Flight Data Recorders

Manufacturing Facility

•Manufacturing Facility

- DOE funded program
- Implement PHM in manufacturing facility

Automotive

•Automotive Industry On-Board Diagnostics for Emissions

- Robust algorithm development for emissions control
- Pattern recognition and decision algorithms

F-16 ADG

•Flight-critical Systems

- Joint Shared Vision program with LM Aero
- Extend replacement intervals for Accessory Drive Gearbox (ADG)

Airborne Laser (ABL)

•Fluid Flow

- Program with MDA and Industry
- Implement PHM on fluid flow systems (COIL)

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SNL Technologies Support PHM

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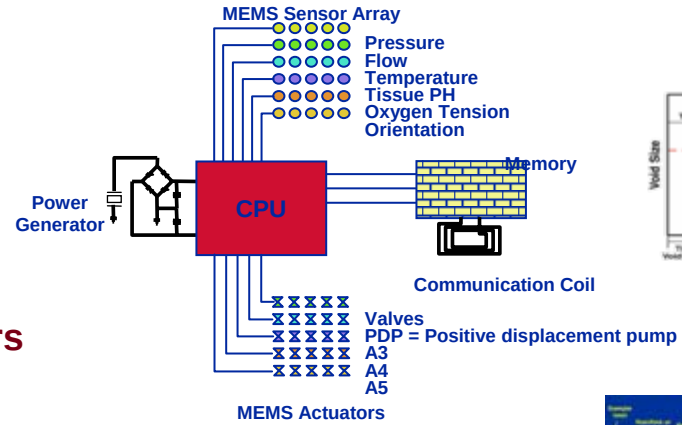
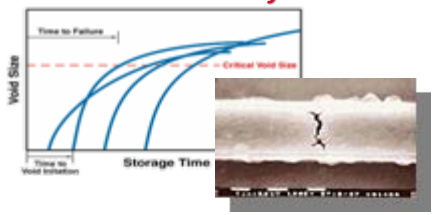
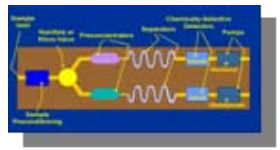
- **Modeling & Simulation**
  - Predictive analyses
  - Sensitivity/Uncertainty analyses
  - Optimization analyses
- **Microsensor Development**
  - Fiber-optic chemical sensors
  - Integrated/Micromachine Sensors
  - Wireless, self-powered sensors
- **Life Prediction Algorithms**
  - Fuzzy Logic
  - Neural networks, Bayesian networks
  - Genetic Algorithms
  - Bayesian updating
- **Electronics Quality/Reliability Center**
  - Failure analysis
  - Burn-in elimination & testing
  - Life prediction
- **Materials Aging**
  - Life extension
  - Reliability predictions



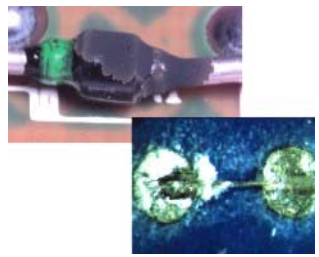
Wireless, Self-Powered MEMS Sensor & Actuator

Void Growth Analysis

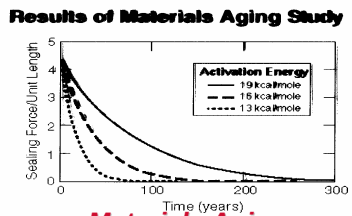




MEMS Technology



Corrosion Analysis



Materials Aging

Sandia's Nuclear Weapons Enhanced Surveillance & Life Extension and National Defense programs

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Preliminary Facility Layout

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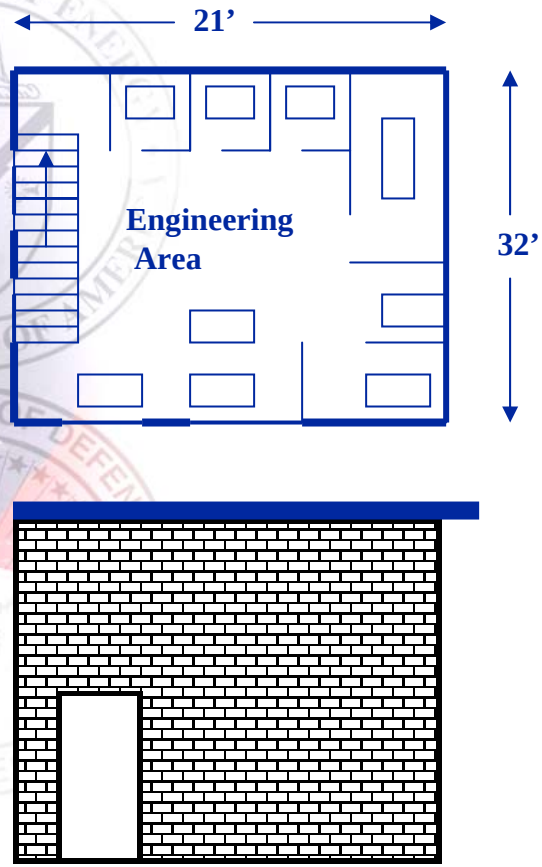

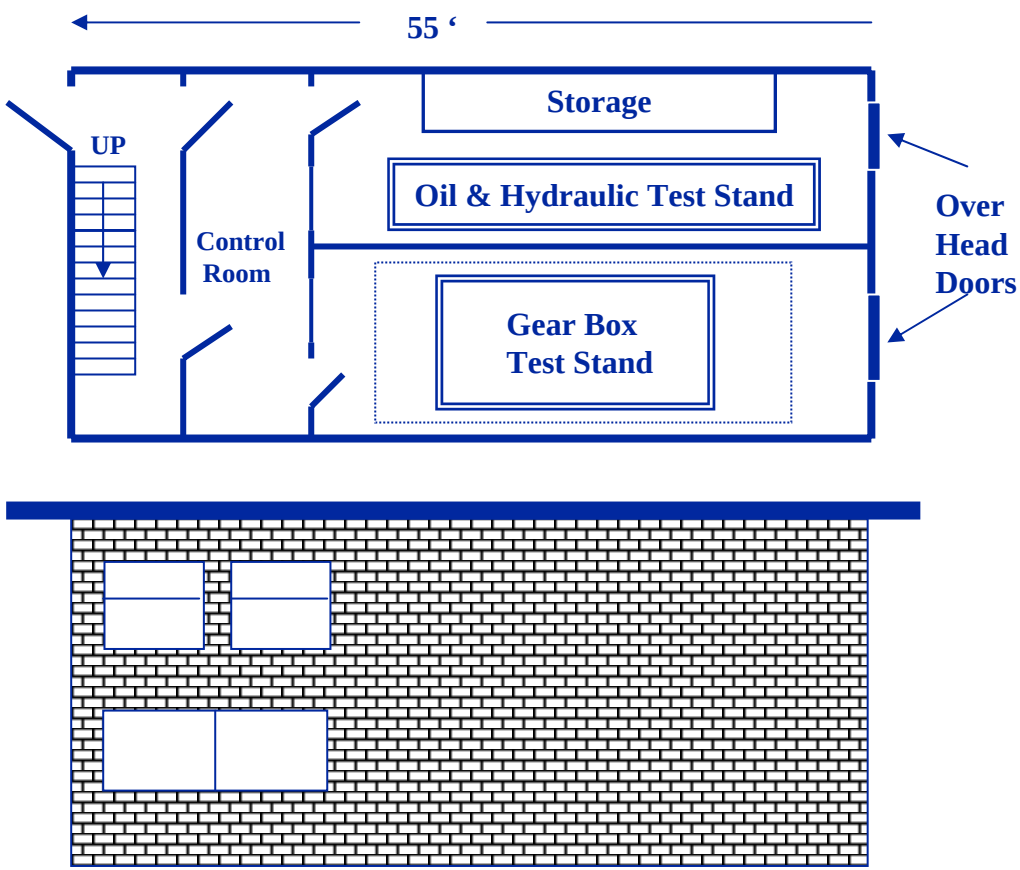

Front Elevation

Side Elevation

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- ***250-acre Research Park has 9 companies employing over 500 people***
  - ***Virtual extension of Sandia***
  - ***Strongly endorsed by New Mexico political leaders***

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