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The Transition of the Nuclear Weapons Stockpile Towards Nuclear-Zero

Impacts on Stockpile Surveillance

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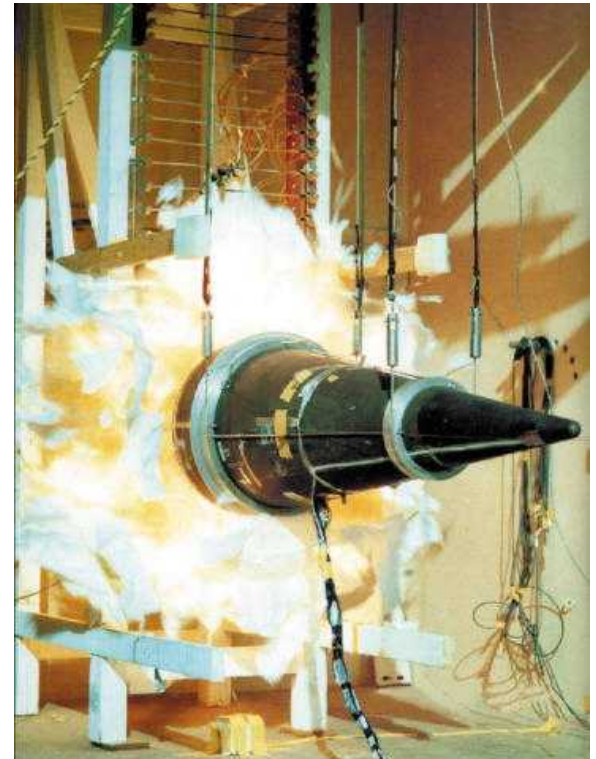**Member of the Technical Staff**

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Impacts and Motivation

- **A declining stockpile means…**
  - Funding uncertainties
  - Systems and subpopulations reduced/eliminated
    - *Role/Importance of remaining systems increases*
  - Surveillance methodology breaks down

- **"The surveillance program is becoming inadequate" – JASON, 2009**
  - Propose new testing methodology

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Background

Stockpile Stewardship Program

- **Purpose: Establish the reliability of the stockpile through <u>simulation</u> and non-nuclear <u>experimental testing</u>**
  - *Detect defects*
  - *Provide predictive assessment*
  - *QMU*
- **Results: Annual certification of the stockpile**

Simulation

- **Computational models**
  - **Aids in our fundamental understanding**
  - **Rarely uncovers manufacturing "defects"**
    - *Unknown failure modes*

Experimental Testing

- **Lab**
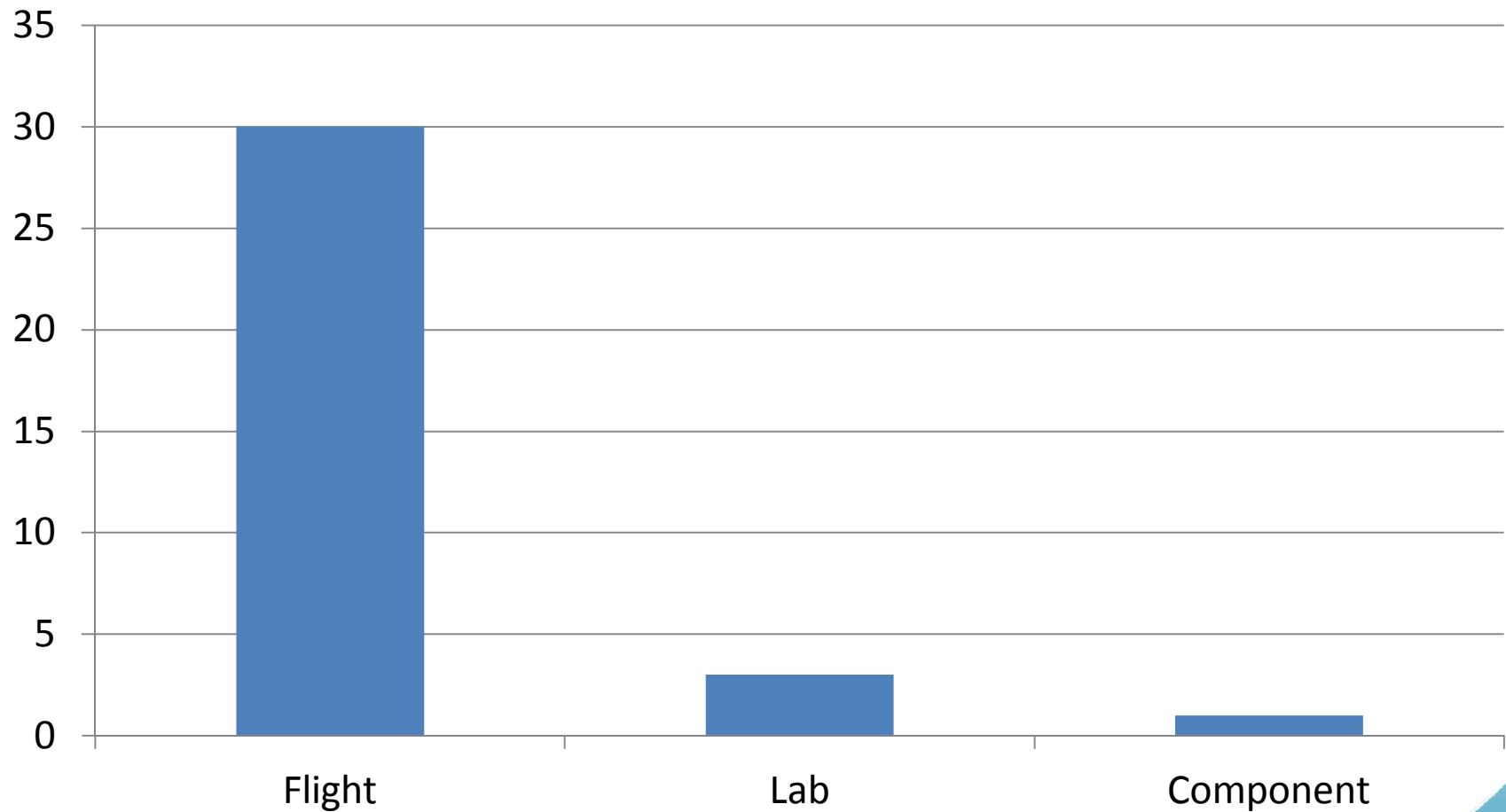 - Systems and subsystems tested in controlled environments

- **Flight**
  - Joint Test Assemblies (JTAs).

- **Component**
  - Cycle testing of single components

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Normalized Cost Per Year*

*Rough Estimate

6

Current Approach

- **90-10-3 method**
  - 90% confidence that we can uncover a defect affecting as many as 10% of the stockpile in under 3 years through simulation and testing
  - Reliability models break down as you go to lower numbers

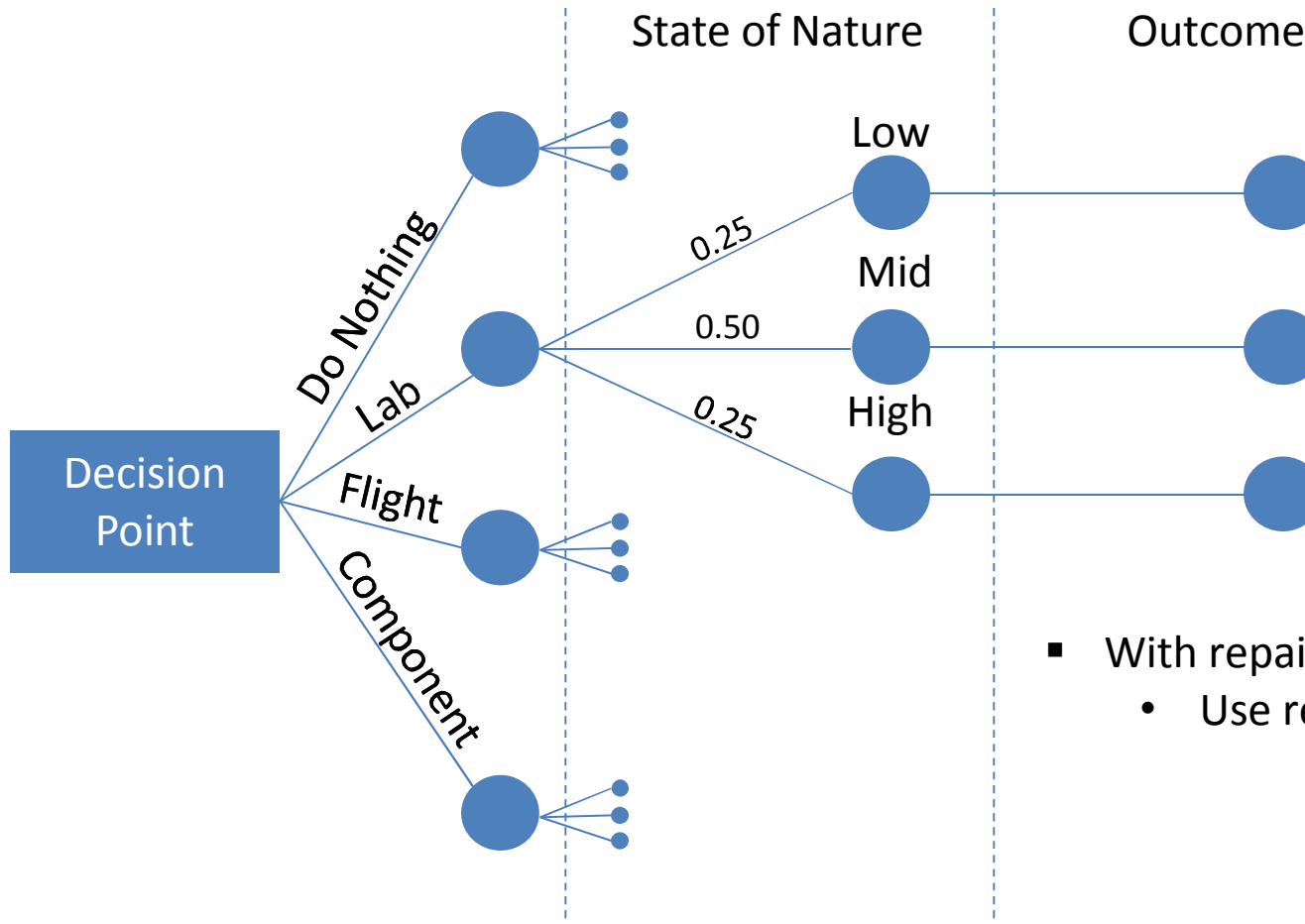Sandia National Laboratories

Suggested Approach

- **Decision Analysis**
  - Determine the most logical testing methods by associating measure of value.

- **Optimization through Zero-Sum Game Theory**
  - Allows you to choose an optimal "blend" of testing methods to minimize risk given finite resources.

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Decision Analysis

State of Nature   Outcome

Do Nothing

Lab

Flight

Component

Decision Point

Low

0.25

Mid

0.50

High

0.25

- With repair and replacement
  - Use reliability growth model

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Optimization

	Low	Mid	High
Flight	3	4	5
Lab	5	4	3
Component	8	5	2

Use constraint equations to choose an optimal solution
- Money, time, test assets

Future Work

- **Need to quantify risk for each alternative**
  - **Customer utility function**
    - *What is an acceptable level of risk*
  - **What is the historical defect detection rate in the various testing methods?**
  - **Need to understand reliability growth**
    - *How does the reliability of the stockpile change through these testing methods over time?*
- **Sensitivity Analysis**

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Challenges

- **Subpopulations**

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Summary

- **90-10-3 is inefficient**

- **DA and GT can be applied to optimize testing methodology**

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