Statistical Models for Stockpile Health Assessment

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The Los Alamos National Laboratory (LANL) Statistical Sciences Group (CCS-6) has an ongoing applied research effort to develop methods and software tools to help assess the health of the enduring U.S. nuclear stockpile. Given the complex scientific and data issues associated with understanding the stockpile, CCS-6 works within LANL to apply the best data analysis methods to support decision making. CCS-6 also collaborates with the Department of Defense and other agencies on problems that improve the understanding of weapon stockpile assessment and complex system reliability. (See Figs. 1 and 2).

We have developed statistical methodology for a number of problems arising in reliability assessment, including appropriately handling multilevel data using reliability block diagram and fault tree representations and faithfully dealing with the less than ideal data, which includes biased and incomplete data. Other methodology we have developed is applicable to support quantified margins and uncertainties (QMU) assessments. We have also developed and applied methodology to address a number of questions facing core surveillance and those arising in significant finding investigations (SFIs). Finally, much of the implementation has been done using YADAS, software we have developed to address the statistical challenges often presented by weapons data (see [1] and yadas.lanl.gov).

Our recent successes in supporting the weapons program have included efforts to:

- Combine diverse data types (e.g., pass/fail, accelerated, degradation, lifetime and specification data, and expert judgment) at multiple levels (e.g., system, subsystem, component) to evaluate system reliability. [2,3,4,5].
- Take indirect measurements to make inference about characteristics based on direct measurements that were not taken [6].
- Estimate the proportion of a population with an attribute from data that were purposely biased to contain units with that attribute [7,8].
- Analyze degradation with a model that implies a Weibull lifetime distribution and assess reliability [9].
- Support QMU assessments with statistical models and analyses [10].
- Understand how reduced data collection impacts reliability.
- Understand how to collect degradation data over time for applications like shelf-life programs [11].
- Track and trend surveillance streams from LANL stockpile weapons to help assess stockpile health (see Fig. 3)[12].

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Fig. 1.
Andrew Wiedlea and Nick Hengartner examine a test set used to collect data on the health and functionality of missile components from weapons like the **MK 67** *submarine-launched mine in the picture.*

Fig. 2.
CCS-6 is collaborating with the Naval Surface Warfare Center to assess the reliability of the RAM missile system.

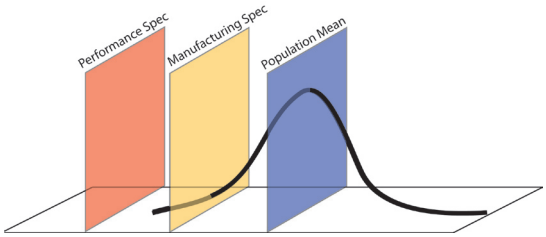

Fig. 3.
CCS-6 is working with the LANL Core and Enhanced Surveillance programs to track and trend weapon surveillance data streams. The goal is to assess key weapon characteristics against known specifications and estimate the distribution of these characteristics in the stockpile now and in the future.