The Role of the Revised IEEE Standard Dictionary of Measures of the Software Aspects of Dependability in Software Acquisition

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Outline

- Introduction
- Rationale for Revision
- Criteria for Measure Inclusion
- Benefits for DoD Program and Project Managers
- Assessment
- Prediction
- Product Dependability / Process Improvement Integration
- Benefits for the DoD Acquisition Manager
- New Measure Example
- Summary

Introduction

- Standard Dictionary of Measures of the Software Aspects of Dependability
- Dependability
  - Trustworthiness of a computer system such that reliance can be justifiably placed on the service it delivers.
- Scope
  - Specify and classify measures of the software aspects of dependability.
  - Provide conventions for the application and use of these measures.

Introduction

- Purpose
- Provide measures that are applicable for continual self-assessment and improvement of the software aspects of dependability
- The first standard will be a small document with just a few core measures dealing with reliability, maintainability, and availability.
- This will be followed by a second standard that will address safety, confidentially, and integrity.

Rationale for Revision

- Not revised since 1988.
- Reaffirmed in 1996, but there were significant negative comments.
- Revised because many of the original measures had undesirable characteristics:
  - Naivety about the necessary data, personnel capabilities, and training to effectively use the measures.
  - Did not measure what they purported to measure.
  - Little field data to back up claims for benefits.
  - Measures were not widely used.

Criteria for Measure Inclusion

- Have measures helped acquisition personnel, developers, and users achieve their reliability goals?
  - Some minimum number of recognized uses.
  - Demonstrated or potential utility of the measure in producing reliable software.
- Formulated generic measure classes:
  - Reliability, Availability, and Maintainability.

Criteria for Measure Inclusion

- Determined whether existing measures should be modified, retained, or deleted, based on the criteria.
- Added any additional information on the measures developed since 1988.
- Clarified definition and implementation conventions.
- Identified and incorporated, where appropriate, new measures that have appeared since 1988.

Benefits for DoD Program and Project Managers

- Provide technology for DoD program and project managers:
  - Apply measures of dependability:
    - To assess and predict the dependability of software during test and operation.

Assessment

- Make an evaluation of dependability from a historical perspective (e.g., MTTF).
- For the manager, assessment answers the question: how dependable has my software been in the past?
- If for example, the software has not met reliability and availability goals, it may be necessary to strengthen process steps, such as inspections and testing.

Prediction

- Forecast the future dependability of the software.
- Use failure data obtained during test to fit a model for making predictions of reliability during operation and maintenance:
  - *time to next failure*, *remaining failures*, *total failures over the life of the software*
- For the manager, prediction answers the questions: How reliable is my software likely to be in the future?
- If it will not meet reliability goals, what actions are necessary to correct the situation?

Product Dependability / Process Improvement Integration

- For both assessment and prediction, there may be process improvements that could be made to bring the reliability of the software up to the goals established in the specifications.
- Organizations that have the capability to measure their products and use these measurements to guide process improvement are those with the highest CMM ratings, such as the NASA Space Shuttle avionics software.

Benefits for the DoD Acquisition Manager

- There is much emphasis in DoD on integrating COTS into host systems due to the possible reduction in software development cost compared to developing the software in-house.
- These components must be reliable, maintainable, and available, and must interoperate with the host system in order for the customer to benefit from the advertised advantages of lower development and maintenance costs.
- To ensure compliance with these goals, the acquisition manager would specify in COTS contracts the dependability measures of this standard.

New Measure Example

- Risk Factor Regression Model
- Definitions
  - CF = d*(exp(e*CI)):
  - Cumulative requirements issues reliability prediction equation.
  - Issues: number of possible conflicting requirements.
  - RF (Risk Factor): attributes of a requirements change that can induce reliability risk.

New Measure Example

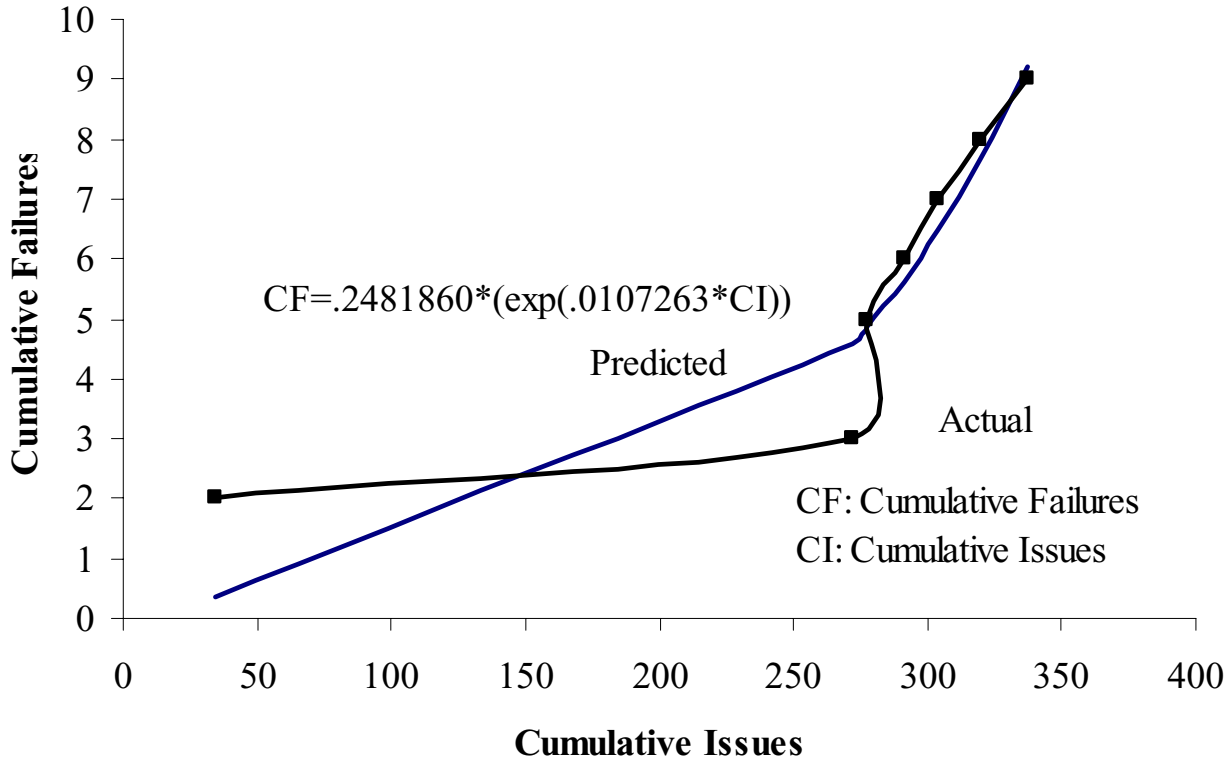
- Variables
  - CF: Cumulative Failures.
  - CI: Cumulative Issues.
- Parameters
- Coefficients of non-linear regression equations:
  - d, e.

Requirements Change Threshold

- In Figure 1, cumulative failures are plotted against cumulative requirements issues, for both actual and predicted cases. When *issues* reach 272, actual cumulative failures reach three and climb rapidly thereafter.
- In this case, a cumulative failure count of three has been identified as a *critical* value.

Reliability as a Function of Requirements Issues

Figure 1: Failures vs. Issues

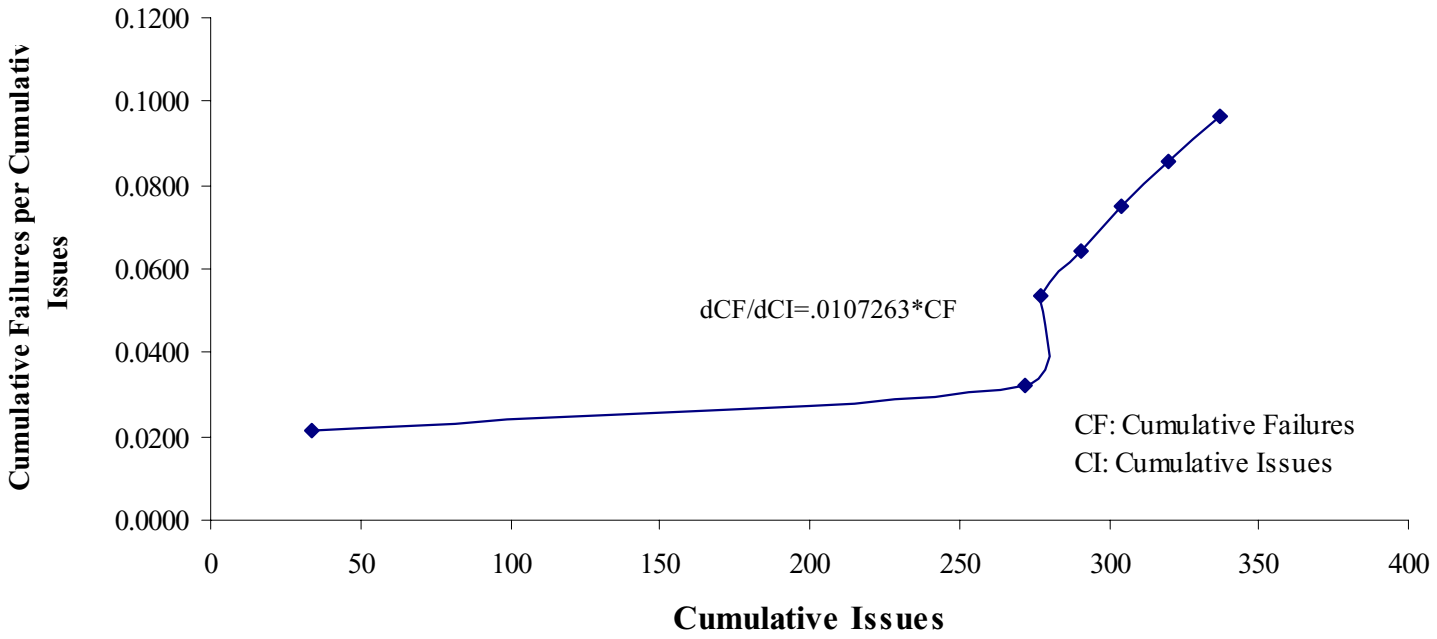


Rate of Change of Reliability

- Because the equation in Figure 1 is an exponential, its derivative is also an exponential and is simply the original function multiplied by a constant. This plot is shown in Figure 2.
- We should have concern about the negative effect on reliability of *issues* because of its predicted explosive growth rate.

Rate of Change of Reliability as a Function of Requirements Issues

Figure 2. Rate of Change of Failures with Issues



New Measure Example

- Application
  - Provide warning to software managers of impending reliability problems early in the development cycle -- during requirements analysis – by using risk factors to predict reliability.
  - Software managers would be to anticipate problems rather than react to them.
  - More efficient software management would be possible because, with advance warning of reliability problems, management would be able to better schedule and prioritize development process activities.

New Measure Example

- Data Requirements
  - Cumulative failure count.
  - Cumulative requirements issues count.
- Units of Measurement
  - Dimensionless numbers.
- Experience
  - Proposed for NASA-wide adoption.
- Tools
  - SMERFS, CASRE, EXCEL, S-PLUS 6.

Summary

- IEEE 982.1 provides a strategy and technology for DoD managers to ensure the dependability of their software during acquisition, test, operations, and maintenance.