

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

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Report Documentation Page

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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

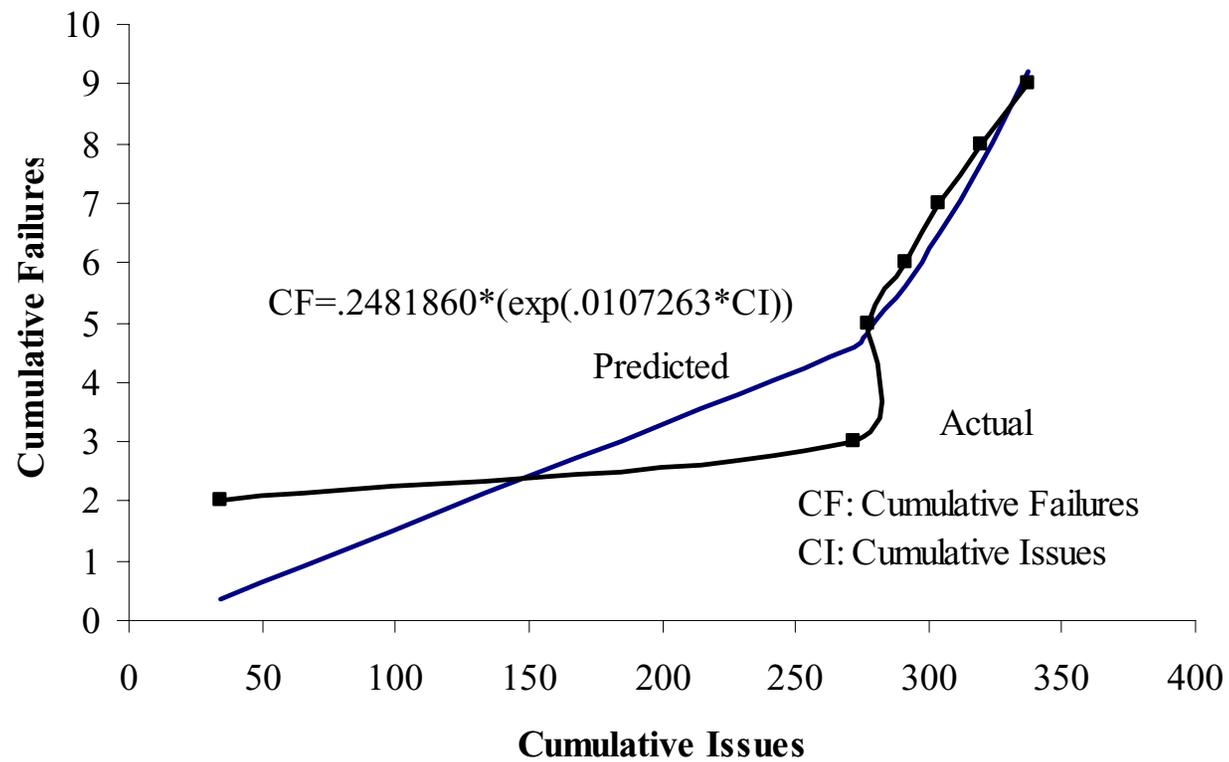
- Variables
 - CF: Cumulative Failures.
 - CI: Cumulative Issues.
- Parameters
- Coefficients of non-linear regression equations:
 - d, e.

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

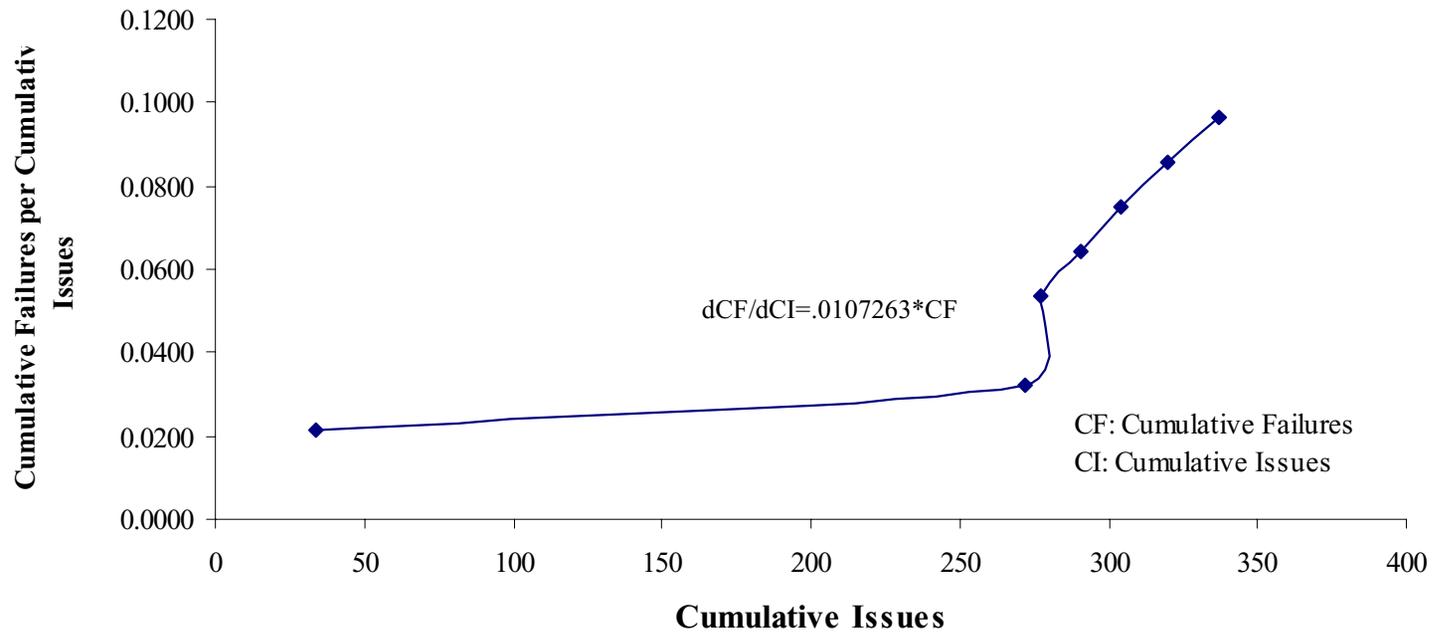


Rate of Change of Reliability

- 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**.