RDC.XLS: A SIMPLE TOOL FOR PRODUCING RELIABILITY DEMONSTRATION CHARTS

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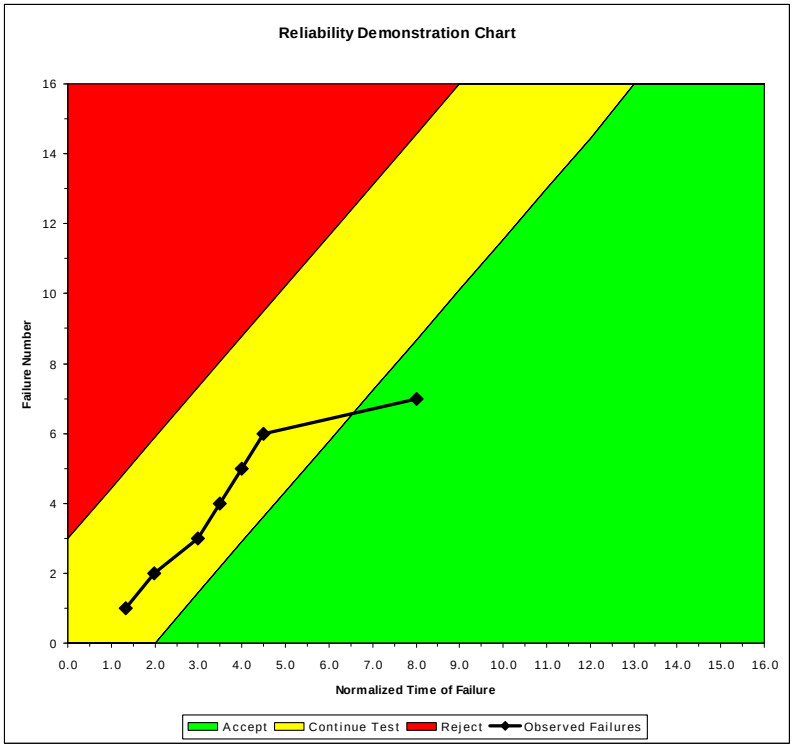
Abstract. An open-source tool for producing a reliability demonstration chart is described. The user inputs risk preference parameters and failure times. A graph indicates that a failure intensity objective is (is not) met, or to continue testing.

The Reliability Demonstration Chart. A reliability demonstration chart (RDC) shows when cumulative failure observations indicate that a failure intensity objective has or has not been met. [3, 4] It is assumed that the failure data is produced by test cases that follow an operational profile. An RDC graph plots cumulative number failures versus normalized time of failure. The graph has three regions that indicate (1) that the tests are strong evidence that the system under test (SUT) will achieve its failure intensity objective ("accept"), (2) that more testing is needed to make a determination ("continue"), or (3) that the SUT cannot achieve its failure intensity objective ('reject"). Figure 1 shows an example chart produced by RDC.xls.



Risk Tolerance Parameters. The three action outputs (accept, continue, reject) directly reflect the producer's tolerance for error in estimating the actual reliability of the SUT. The user's risk tolerance is expressed with three input parameters, either from presets or the user's own values.

- α: Producer's risk threshold. The highest probability the producer is willing to accept that the model will incorrectly indicate "reject", when the SUT would meet or surpass its failure intensity objective.
- β: Customer's risk threshold. The highest probability the producer is willing to accept that the model will incorrectly indicate "accept", when the SUT would not meet or surpass its failure intensity objective.
- γ: the discrimination ratio. This is the error in estimating failure intensity the developer is willing to accept. "The discrimination ratio is the ratio of the upper test MTBF to the lower test MTBF and is a measure of the power of the test to reach a decision quickly and, together with the decision risks, define a sequential test's accept-reject criteria. In general, the higher the discrimination ratio, the shorter the test." [1]

These parameters determine the graph region boundaries. They represent the producer's expectation of both opportunity (time to market) and failure (rework and remediation) costs. For example, lowering risk parameter values expands the continue region towards the northwest and southeast corners. This typically means more testing will be needed to cross a boundary while reducing the chance that a satisfactory SUT is rejected or an unsatisfactory SUT is accepted. In a time-to-market race, higher risk tolerances could be used, narrowing the continue region. In either case, decision makers can weigh the consequences and make a release decision using explicit risk quantification without excessive test costs.

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Design Goals

Although the RDC is a key element in the industrial application of SRE [2, 4] and its mathematics are well-established [1, 3] no readily available software tool can produce an RDC chart. RDC.xls was developed to fill this gap. Its main design goals were:

- Provide predefined risk tolerance profiles, following [4].
- Allow a user to select a predefined risk tolerance profile.
- Allow a user to add a custom risk tolerance profile.
- Accept the same failure data required for CASRE (observed failure time).
- Immediately generate the RDC graph.
- Produce graphs suitable for industrial decision-making processes and inclusion in documents of record.

Development and Application

Microsoft's Excel provides all of the basic capabilities needed to represent, compute, and graph an RDC. I used Excel 2003. There were two challenges. First, the form of the equations in [4] needed some rewriting to easily produce the x and y coordinates for horizontal and vertical intercepts in the form Excel requires. Second, Excel's graph commands did not readily allow definition of three regions and a data point plot within a single graph object. After considerable experimentation, I found a way to achieve all four elements within a single graph.

The spreadsheet is organized in worksheet tabs: Mode d'emploi (input instructions), R-Demo-Chart (the graphic output), R-Demo-Data (the user's failure data), Risk Parameters (the predefined risk parameters and the user's selection), and Notices (GPL license information.)

RDC.xls is provided under the GNU General Public License to encourage use in the SRE community and beyond. The entire file may be downloaded from Sourceforge [URL TBD.]

Sources

1. --. *Handbook for Reliability Test Methods, Plans, and Environments for engineering, Development Qualification, And Production.* MIL-HDBK-781A. U. S. Department Of Defense, 1996.

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3. Musa, J. D., A. Iannino, and K. Okumoto. *Software Reliability: Measurement, Prediction, Application*, McGraw-Hill, 1987.

4. Musa, J. D. *Software Reliability Engineering: More Reliable Software Faster and Cheaper*, 2nd. ed., AuthorHouse, 2004.

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