PIECES OF PI

"Pieces of Pi" is a series that explores the unique aspects of Reliability, Maintainability and Quality of certain forms of design. It is the author's opinion that reliability and design practices are closely related. The inherent reliability of a product, however it is evaluated, will be governed and limited by the decisions made regarding its design.

Every different way a design is analyzed brings another set of eyes and perspective. As we pore over the design to calculate the stresses on individual parts, we can't help but to think about how the parts are combined to function in an overall system. Perhaps this reliability for new designs will be quantified by field data collected in the future and reliability prediction models will be updated with new "Pi Factors."

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RELIABILITY DATA UNRAVELED

A PIECES OF PI INSTALLMENT

A Casual Astronomer Wonders About Reliability Engineering

Explore a fun, conceptual look at reliability data and how it is viewed within reliability engineering. This installment may be fun, but it's a very rich "Piece of Pi" with many nuances to explore. We have already collected comments about our concept for this installment from other respected voices in reliability engineering and reliability data processing.

We plan on adding more rigor and finer resolution/definition to this vein of conceptual thinking in future installments. **We hope to use this framework to give you a chance to explore Quanterion Solutions' data collection and processing while looking at other methods specific to certain critical industries.**

There is a lot of excellent work in collecting and processing reliability data happening every day in the reliability field.

The universe of reliability engineering is vast; take a look through our telescope with us. A reliable world helps us to take care of our planet, ourselves, and our assets to enjoy many more Pi Days ahead.

If this Piece of Pi installment resonates with you, ask for another "slice" of the story!

I and the rest of the Reliability Engineering Team at Quanterion Solutions welcome your questions and comments!

Sincerely,

- Chris Maxwell.

ABOUT THE AUTHOR

Chris Maxwell, Senior Engineer at Quanterion Solutions, has a BSEE from Rensselaer Polytechnic Institute and an MSEE from SUNY at Binghamton's Watson School of Engineering. After college, he worked for military and commercial entities in fields including communication systems, RADAR analysis and new product development for sensor-based detection and analysis products.

READ ALL THE PIECES OF PI ISSUES: *www.quanterion.com/pieces-of-pi*

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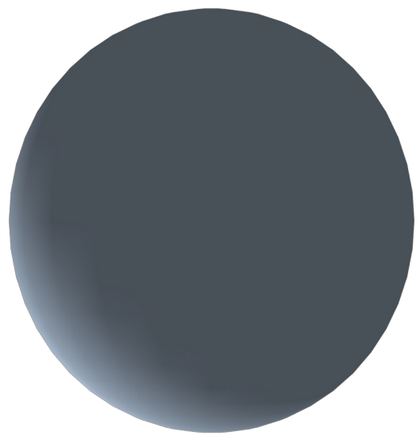
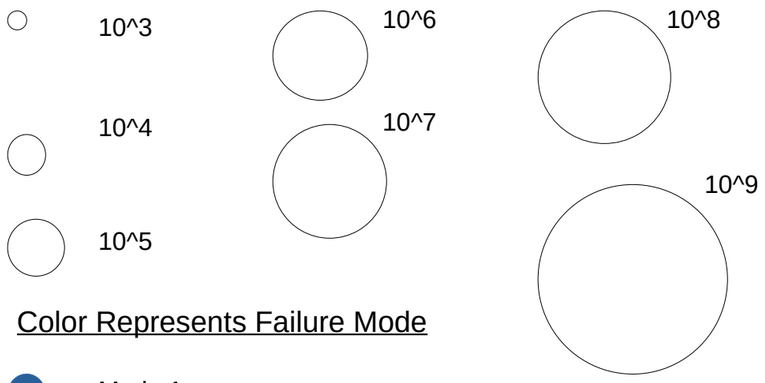
A Casual Astronomer Wonders About Reliability Engineering



LEGEND

The Astronomical Size and Density of Reliability Data

Size Represents The Order of Magnitude of Cumulative Hours (continuous) or Demands (cyclical) in a Data Source



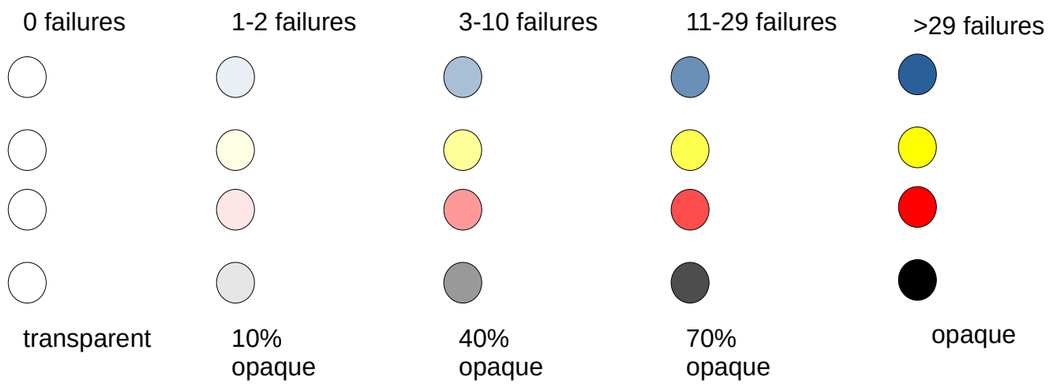
If other units, such as miles, years, etc. are used, it will be noted.

Color Represents Failure Mode

- Mode 1
- Mode 2
- Mode 3
- Failure Mode Unknown or Unreported

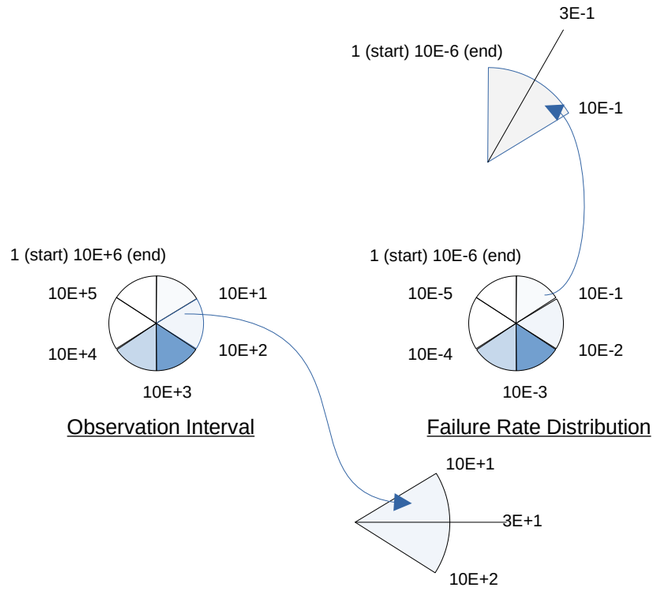
Other colors may be used, if more than three modes need to be represented.

Opacity Represents Number of Failures Documented In a Data Set



Representing the Astronomical and the Infinitesimal Numbers

“Logarithmic Decade Clocks ”



A little “white dwarf” data source of service data on a high reliability part designed with a high safety factor.

Part Quality

“Star cluster” of data sources from annual maintenance activities on a fleet of assets or plants with well defined data collection taxonomies.

A little “white dwarf” data source of life test data on a high quality/reliability part with no failures, yet.

A “gas giant” of a diffuse data record from a few occurrences of a rare failure in millions and millions of hours of exposure

“Moons” of interval data from planned maintenance with no failure mode differentiation.

Design Goal

Part Stress

A “nebulous” data source from a high volume consumer product, with imperfect failure mode characterization.

“Asterioids” of fragmented or poorly implemented data collection.

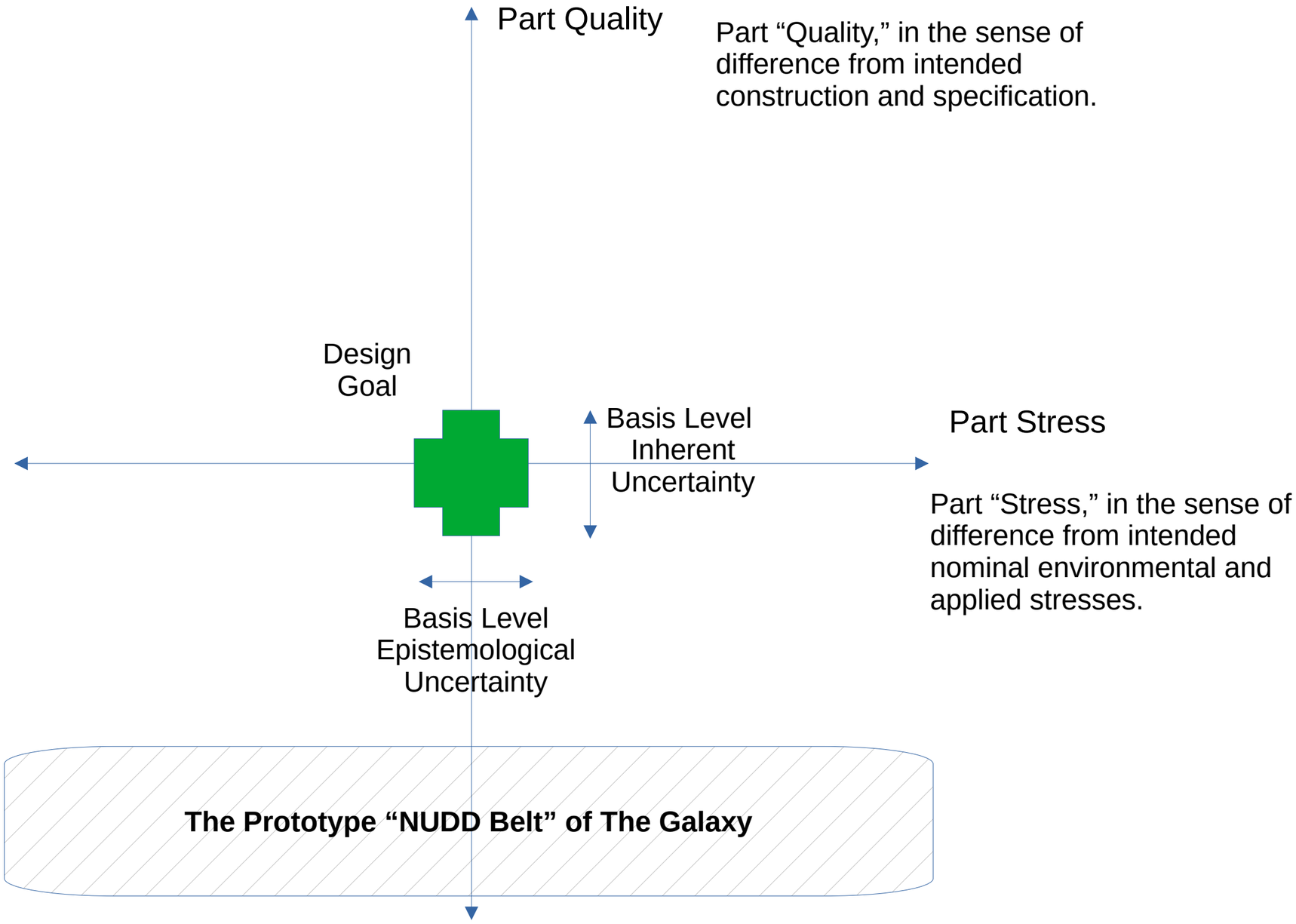
A massive “black hole” data source with no failure mode differentiation

A small “black hole” data source from a prototype part, which failed stress testing due to an unknown failure mode.

A Telescopic View of the Reliability Night Sky

What is being shown?

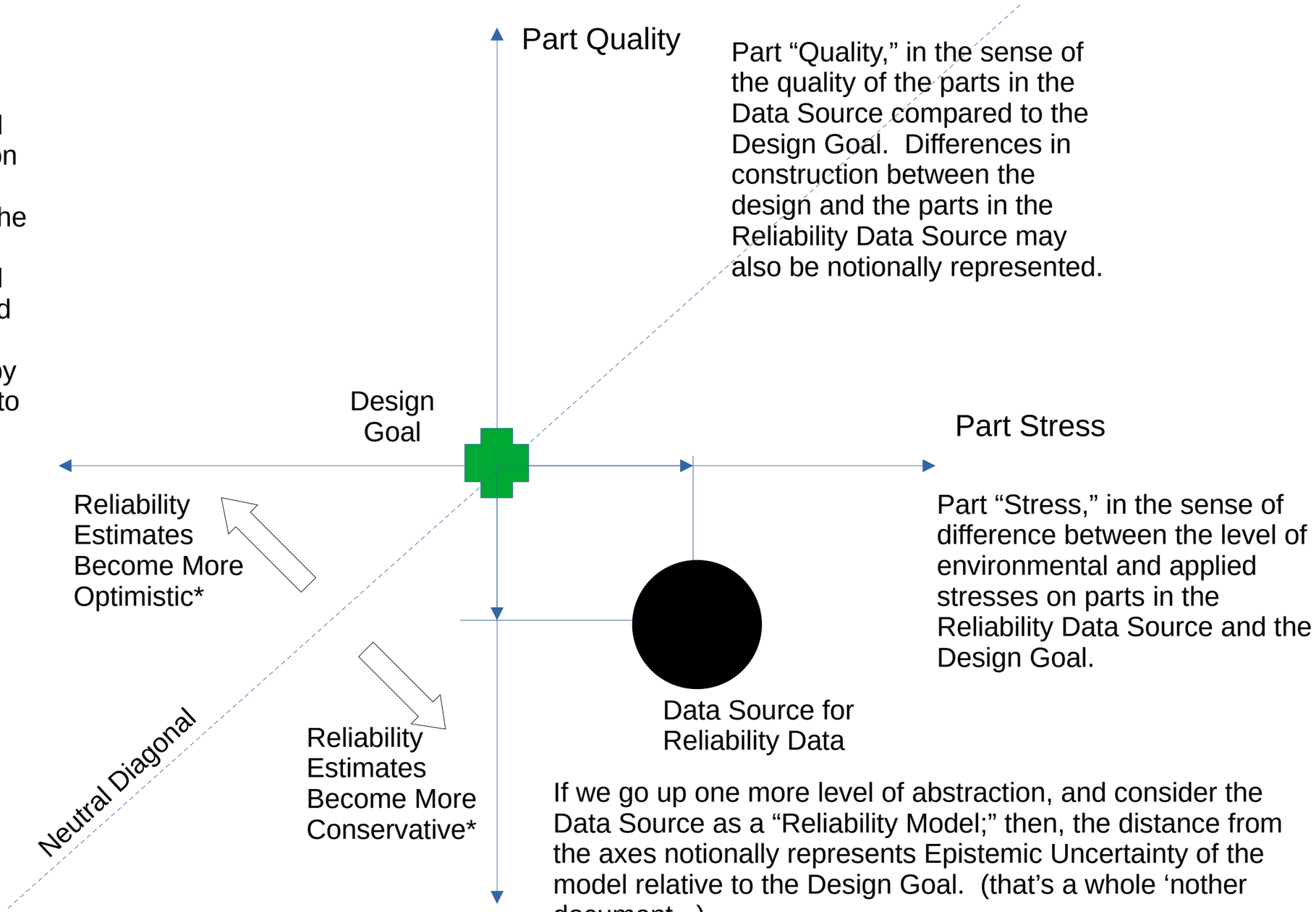
1. The origin is the part's nominal specification.
2. There will always be a variation from part to part. The "Basis Level Inherent Uncertainty."
3. There will always be a variation in the application of stresses and usage environment when the part is fielded. This is the "Basis Level Epistemic Uncertainty."
4. These basis levels notionally represent the absolute minimum uncertainty that can ever be attained with respect to a part's reliability.
5. Prototype parts, especially for NUDD* designs, would often have uncertainties that extend down into the "NUDD Belt" of the Galaxy, as the discovery of new and unscreened failure modes is probable.



The Axes, and How They Relate to Design Goals

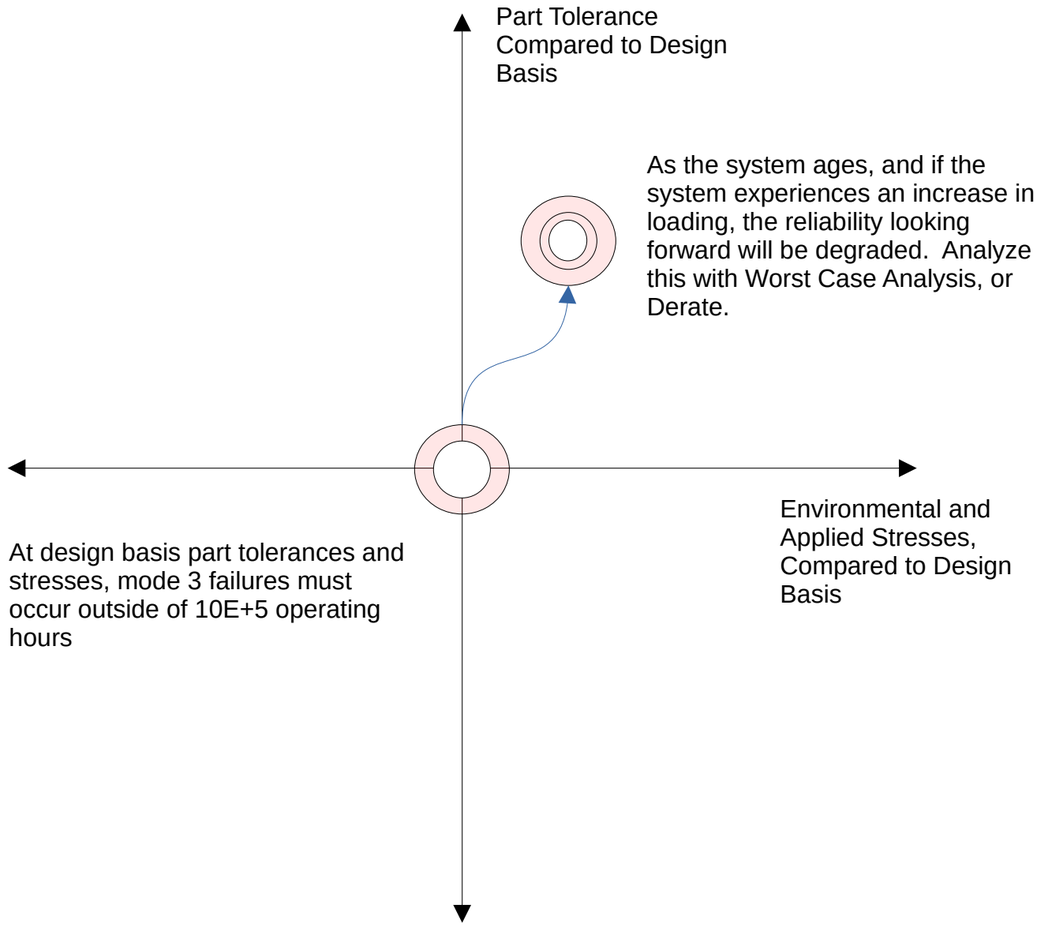
* NUDD: New, Unique, Different and Difficult

What is being shown?
1. The origin is the part's nominal specification for construction and stress.
2. Data Sources are plotted vertically, notionally based on their quality level and construction differences to the intended part.
3. Data Sources are plotted horizontally, notionally based on the stress levels of the environments represented by the Data Source compared to the design goal.

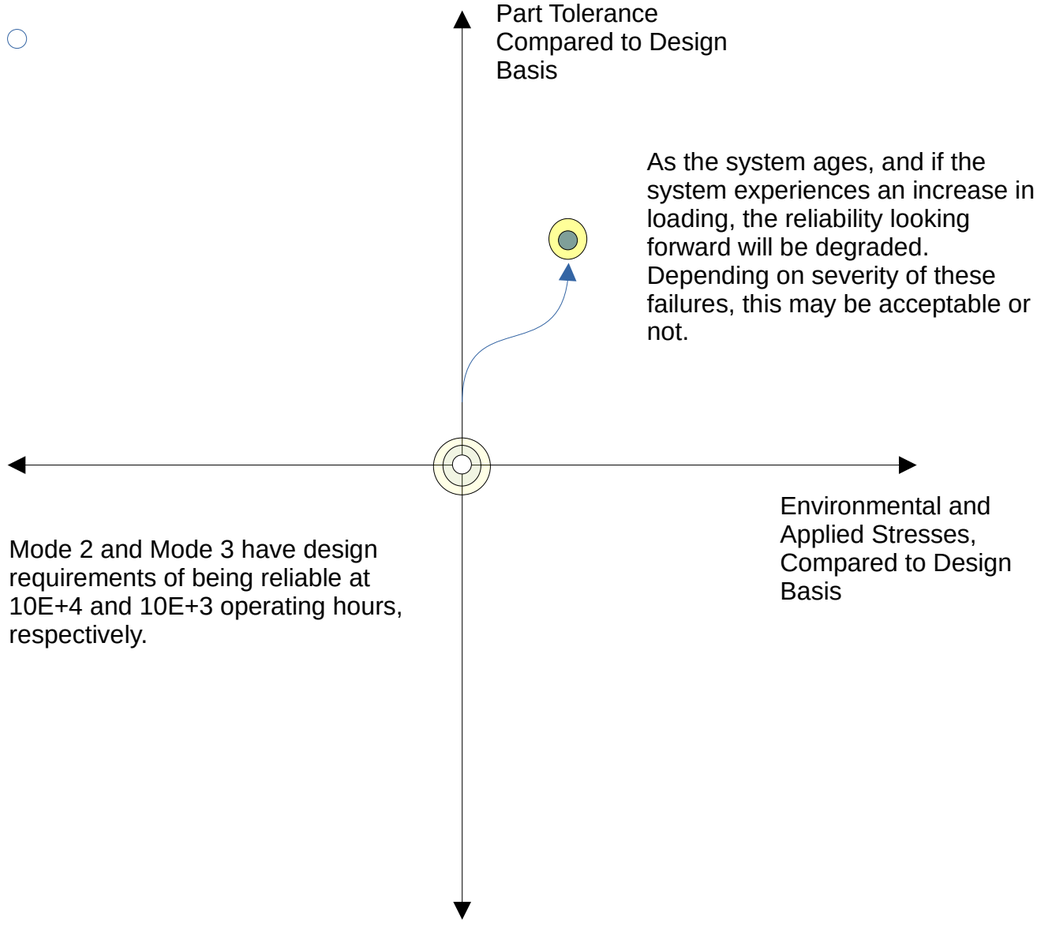


When a Reliability Data Source is Plotted, It has "Relativity" to the Design Goal

* "Optimistic" = Data Source would underestimate the failure rate of the part to be designed/estimated. "Conservative" = Data Source would overestimate the failure rate of the part to be designed/estimated.



How a System Aging Moves Through the Night Sky Over Time, Part 1



How a System Aging Moves Through the Night Sky Over Time, Part 2

EXPLORE DATA AND MODELS TO PERFORM RELIABILITY ANALYSES

Quanterion's databooks and tools are used worldwide to evaluate and improve product and system reliability.

NONELECTRONIC PARTS RELIABILITY DATA - NPRD

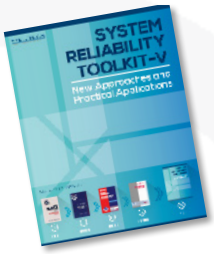
The newly updated Nonelectronic Parts Reliability Data 2023 publication presents field failure rate data on a wide variety of electrical assemblies and electromechanical/mechanical parts and assemblies. The part types and data cover ground, airborne and naval environments.

ELECTRONIC PARTS RELIABILITY DATA - EPRD

The newly updated Electronic Parts Reliability Data 2024 publication contains field failure rate data for commercial and military electronic components for use in reliability analyses. Component types include integrated circuits, discrete semiconductors, resistors, capacitors, and inductors/transformers.

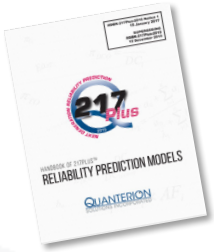
FAILURE MODE / MECHANISM DISTRIBUTIONS - FMD

This databook contains field failure mode and mechanism distribution data on a wide variety of electrical, mechanical, and electromechanical parts and assemblies. This data can be used to assist in the performance of reliability analyses and assessments such as Failure Modes, Effects and Criticality Analysis and Fault Tree Analysis.



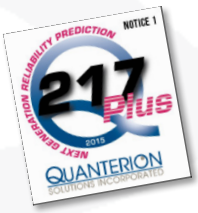
SYSTEM RELIABILITY TOOLKIT-V

This popular toolkit provides technical guidance in all aspects of system reliability. It also includes maintainability, software reliability and human factors. Appendices have been added illustrating the practical application of the selected practices discussed in this document.



HDBK-217PLUS™: 2015, NOTICE 1

Quanterion Solutions developed Notice 1 to the popular 217Plus™ Handbook of Reliability Prediction Models' to supersede the 2015 edition. 217Plus™:2015, Notice 1 replaces the original software reliability prediction model with the Neufelder Model for software reliability prediction contained in IEEE Standard 1633-2016 "IEEE Recommended Practice on Software Reliability."



217PLUS™: 2015, NOTICE 1 SPREADSHEET CALCULATOR

Quanterion's 217Plus™:2015, Notice 1 Reliability Prediction Calculator has been developed to facilitate the failure rate calculation of up to 10 hardware assemblies, and 15 software assemblies, according to the component and system reliability models defined by Quanterion's 217Plus™:2015, Notice 1 methodology.

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