Build4 Scale
U.S. Department of Energy

Sustaining Quality and Warranty

Module 7C Field Product Quality, Service, and Repair

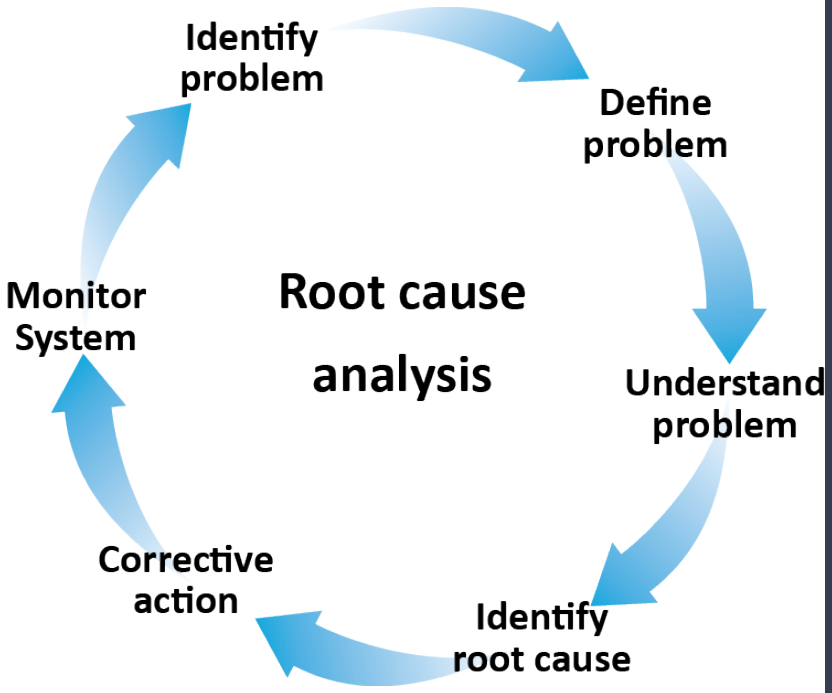
Motivation

Why is this module important?

- Customer reliability expectations (in the field) drive upstream manufacturing and design quality goals

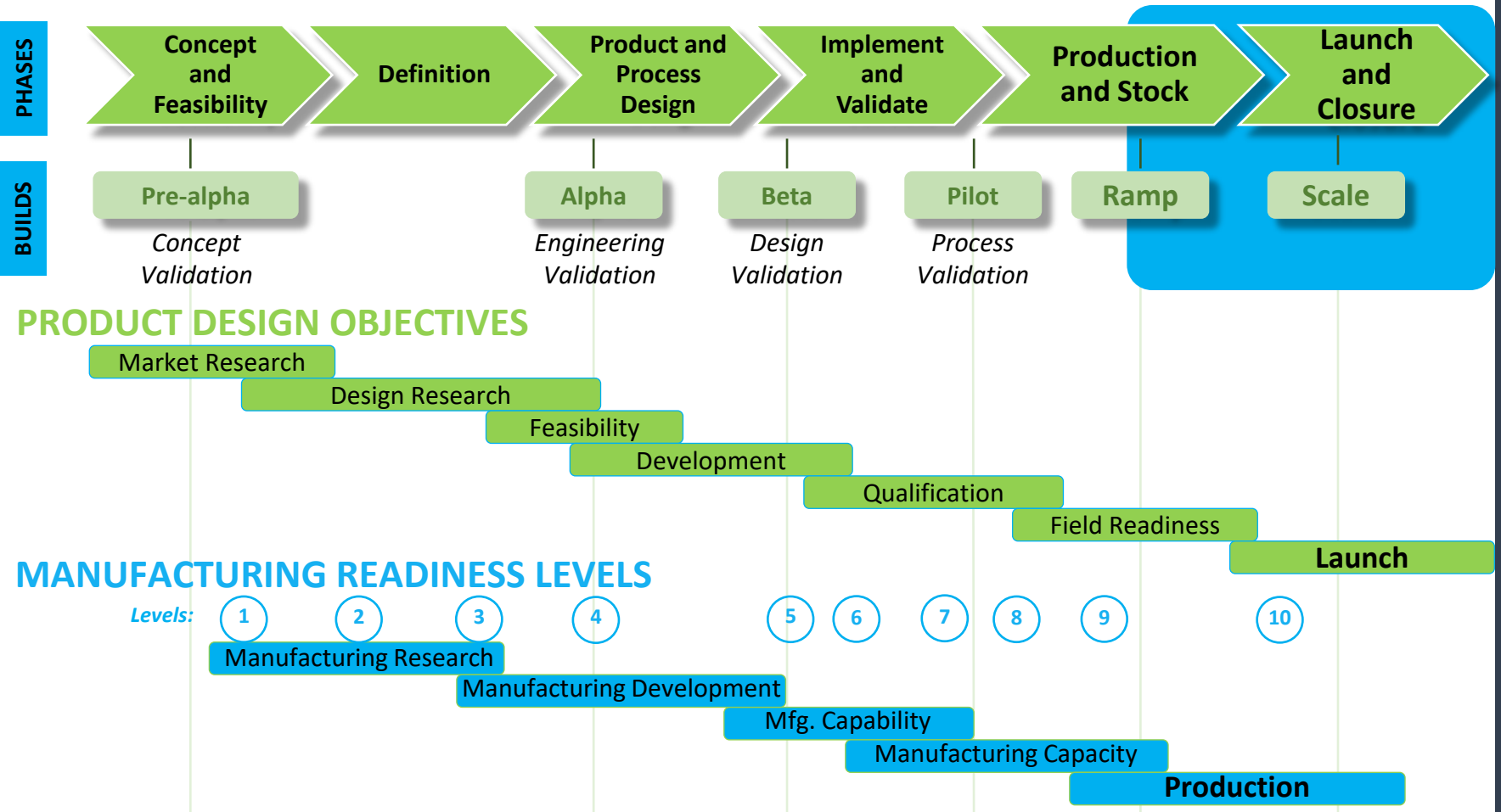
Proactive in-field, use-monitoring activities with appropriate feedback mechanisms enable the following:

- Early identification of unexpected failure trends
- Prioritization of corrective actions based on root cause and value
- Reduced cost through early resolution of problems



Quality, Service, and Repair

Where does this fit into the development cycle?



Module Outline

- Learning objectives
- Information for field quality, service, and repair
- Data analysis and corrective action prioritization
- Complaint resolution—warranty and post warranty

Learning Objectives

- LO1. Understand how to analyze product reliability and test data over time in a value-driven manner
- LO2. Understand the data and feedback loop to prioritize and implement corrective actions

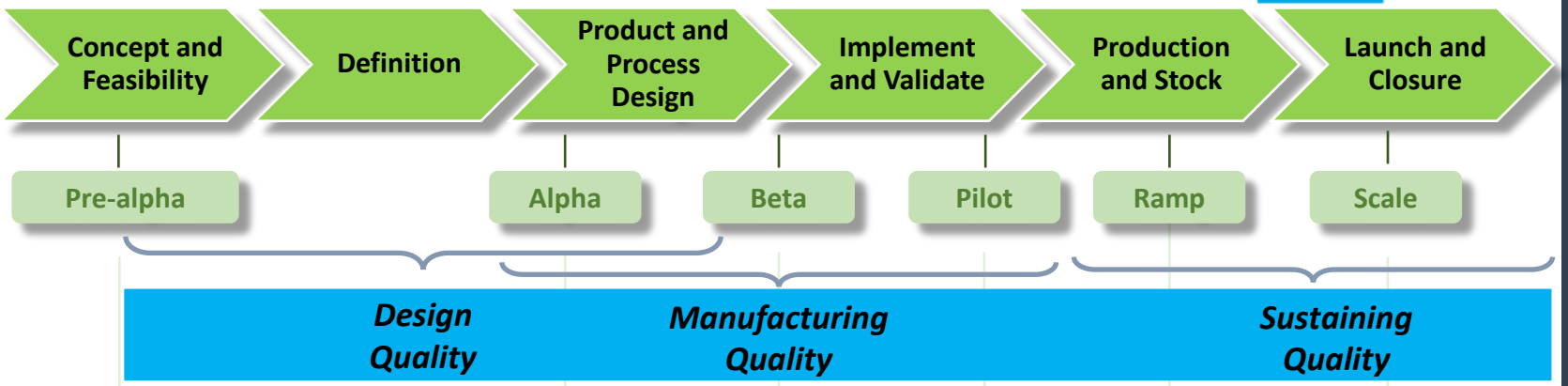
Field, Quality, Service, and Repair

Information drivers

- Customer satisfaction drives your product's market performance
- Data obtained from root cause analysis answer the following questions:
  - —What are the primary root causes for product failures?
  - —Were the original quality and reliability goals appropriate?
  - —Does the manufacturing process enable field reliability goals?
  - —Will the reliability predictions be confirmed over the life of the product?

Understanding Quality

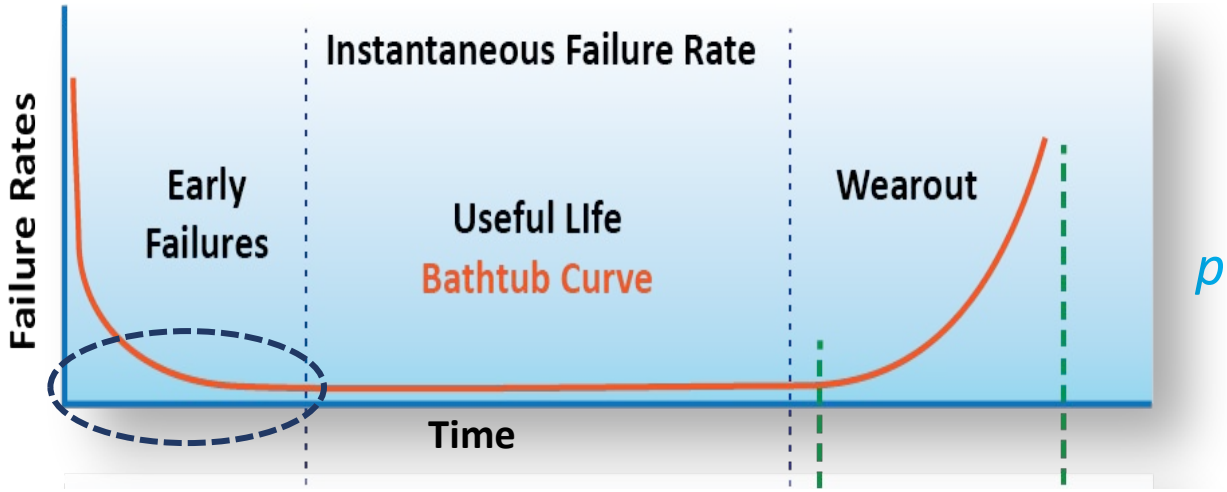
Where does this fit into the development cycle?



- Monitor customer problems/field failures and create action plans to resolve these issues:
  - —Understanding initial design and manufacturing reliability goals
  - —If failures were caused by manufacturing defects/processes, or by the original design (failures are best corrected when **root cause** is found)
  - —Prioritize corrective actions based on the business impacts of field failures (i.e., customer satisfaction, scrap, yield, throughput, and labor costs)

Corrective Action/Prioritization

Early failures, analyzing data/feedback

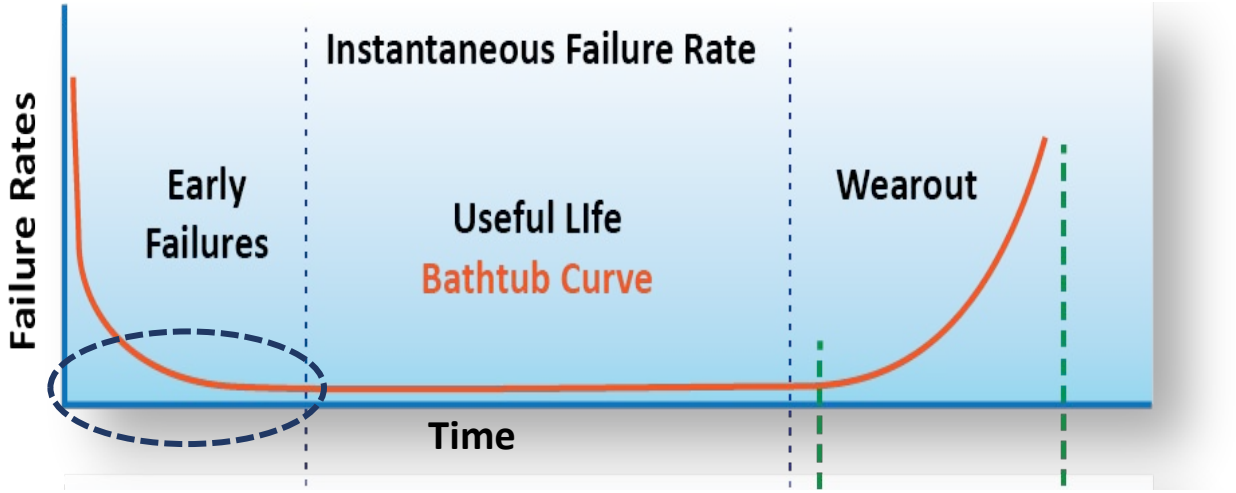


Understand early failures (after product launch) and take them to root cause!

- This is a normal distribution curve
- Early failures are usually attributed to manufacturing quality (i.e., dimension control, material properties, assembly, and installation)
- Prioritize failures based on greatest business impact (i.e., cost and customer satisfaction)

Corrective Action/Prioritization

Early failures, analyzing data/feedback (cont.)

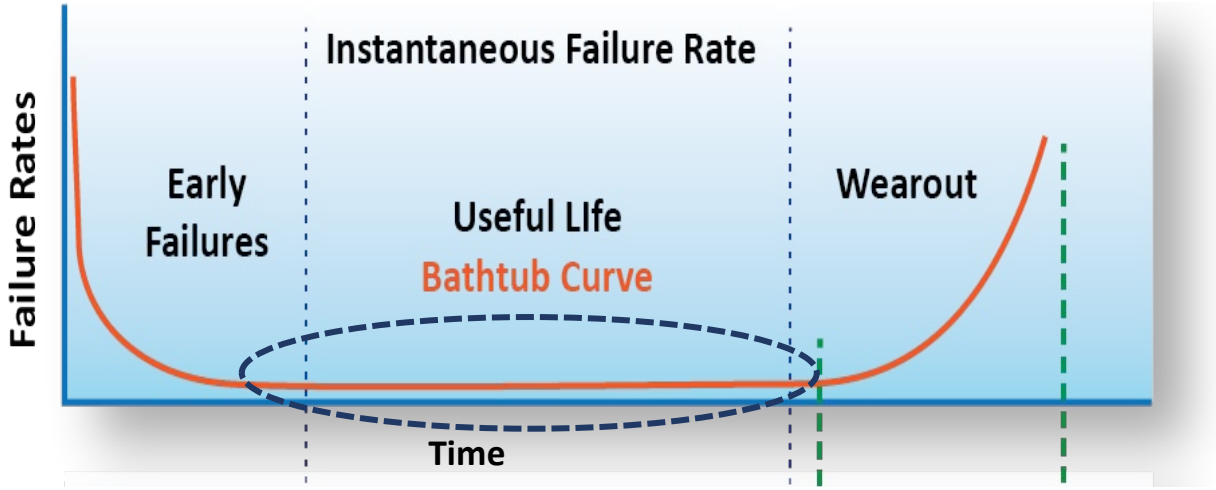


Create a corrective action plan to prevent further failures (could be a manufacturing fix or a product design fix):

- Conduct Out-of-Box analyses (pull "finished" product and inspect top to bottom for issues)
- Develop a statistical sample plan
- If root cause is determined to be manufacturing, consider investments in new equipment, people, and processes to reduce scrap and/or improve yield

Corrective Action/Prioritization

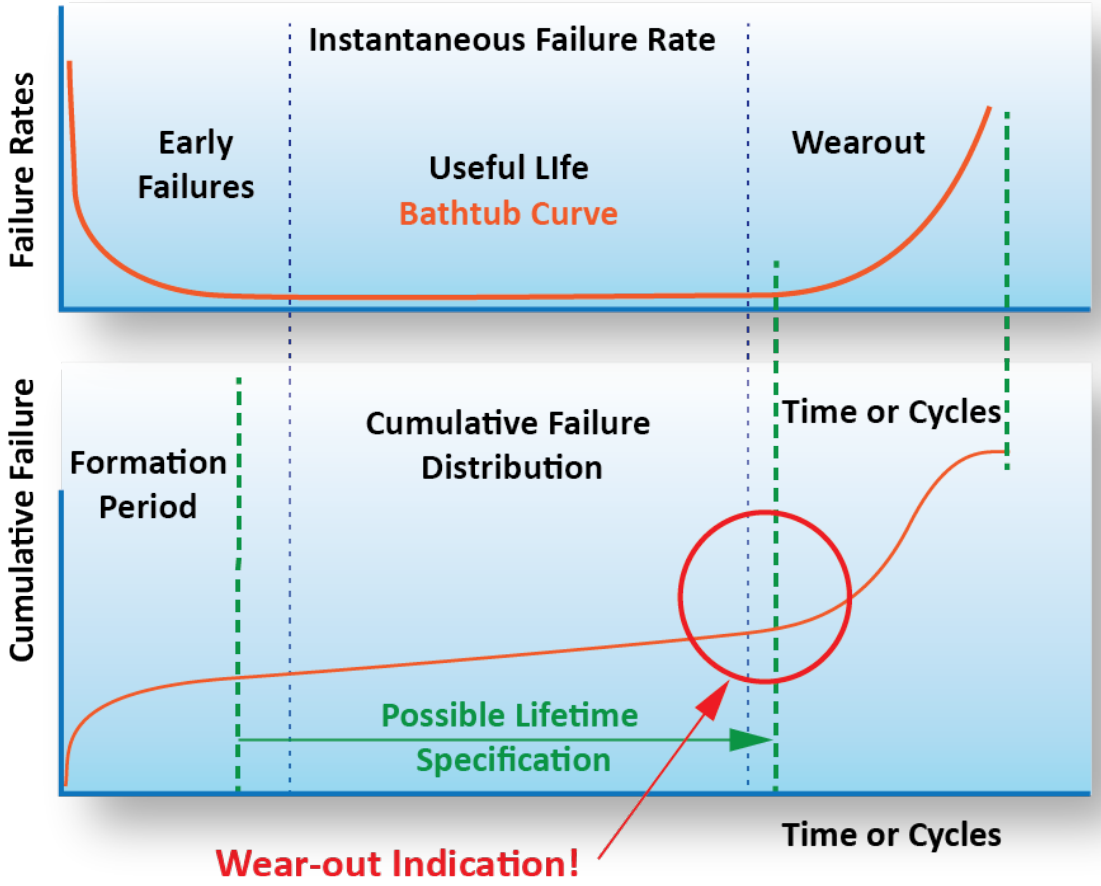
Constant failure rate, analyzing data/feedback



- Early in the product's useful life, do not use the brute-force method of determining the percentage of failures in the field:
  - —Field failure rate percentage = total units divided by number of failures
- This brute-force equation is not a good way of determining field quality from a manufacturing perspective because you will not be able to anticipate a product's failure quickly enough (especially early in the product's lifetime)

Cumulative Failure Distribution

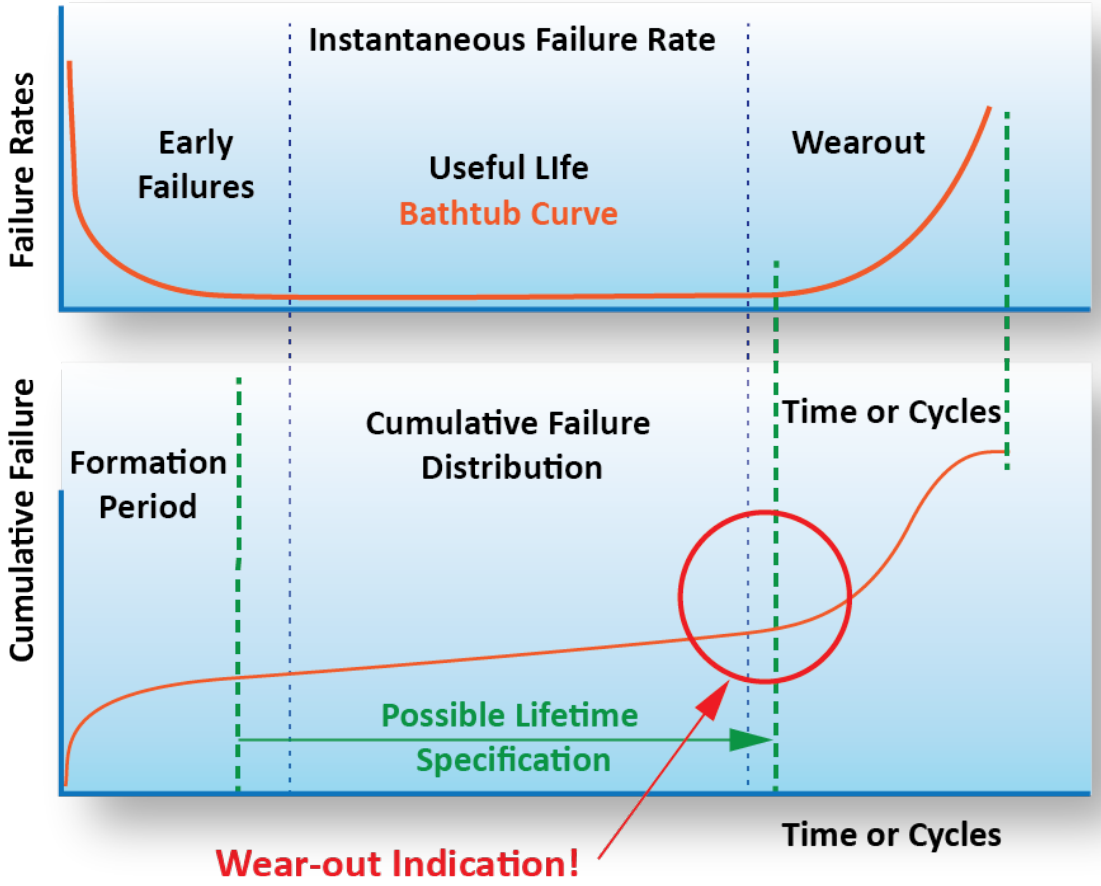
Corrective action/prioritization



- To determine the starting point of product wear-out failures, use a **cumulative distribution function** (CDF)
- The CDF curve is a log-log plot of the same data as the bathtub curve (top). When the straight line (constant failure rate) begins to curve, it is an indication of wear-out failures

Cumulative Failure Distribution

Corrective action/prioritization (cont.)

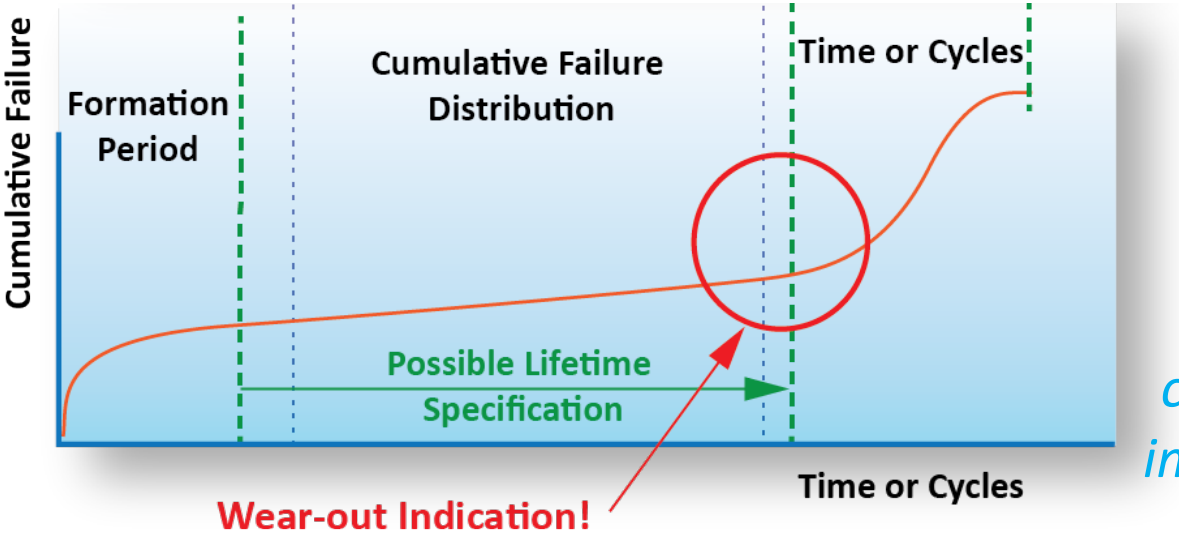


- The CDF curve provides the cumulative probability of when a part and/or assembly might fail

Corrective actions can be made if actual wear-out occurs earlier than predicted

Cumulative Failure Distribution

Corrective action/prioritization (cont.)



Knowing if a part or subassembly is experiencing early wear-out failures is critical to keeping the impact of the failure to a minimum

- Part and system CDFs should be tracked separately
  - —Use the part/sub-assembly CDFs to give early indications that wear out is starting to occur, which allows corrections prior to system failure
  - —Catching wear-out failures in parts/subassemblies as early as possible is critical to ensuring the highest overall system-sustaining quality and lowest possible warranty impact

Customer Complaint Resolution

Best practices

- Be an active participant in all service and repair discussions
- Understand the customer's expectations versus actual issues and complaints (perception is reality to customer satisfaction)
- Closely track early failures and drive quickly to root causes
- Know that the design intent and manufacturing processes will help direct issue resolution to the correct department quickly

Customer Complaint Resolution

Best practices (cont.)

- Understand the biggest business impacts from failures and prioritize corrections to manufacturing processes and/or design improvements
- Verify that all issues were resolved and follow up with the customer to explain the root cause of the problem and how corrective actions were implemented
- Provide the most value to your customers and to your business by understanding the quality drivers across the entire product lifecycle

List Of Terms

In glossary

- **Root Cause** is an initiating cause of either a condition or a causal chain that leads to an outcome or effect of interest.
- **Cumulative Distribution Function (CDF)** of a real-valued random variable *X* is the function given by F X (x) = P (X ≤ x) , {\displaystyle F_{X}(x)=\operatorname {P} (X\leq x),} where the right-hand side represents the probability that the random variable *X* takes on a value less than or equal to *x*.