Subject- Operations Management
Topic- Reliability and Bath -tub curve

Lecture Notes

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Reliability

- Reliability of any product or component is the **probability** to perform **intended function** under prescribed **operating conditions** for a **stated period of time** .
- Reliability is the science to predict, analyze, prevent and mitigate failures over time.
- Reliability involves the aspects like:
  - Property possession
  - Cost management
  - Customer satisfaction
  - Resource management
  - Ability to sell product or service
  - Quality and safety of product

Basic objectives of reliability engineering

This objectives are chronological in order :

1. To apply engineering knowledge and experience to prevent or reduce frequency of failures.
2. To identify and correct the causes that do occur.
3. To determine the ways to coping failures if the causes of failures have not been corrected.

Causes of failure

Failure is defined as the ‘state of fault’. There are many causes of failures but due to complexity of system some are known and some causes are unknown. Some causes of failures are:

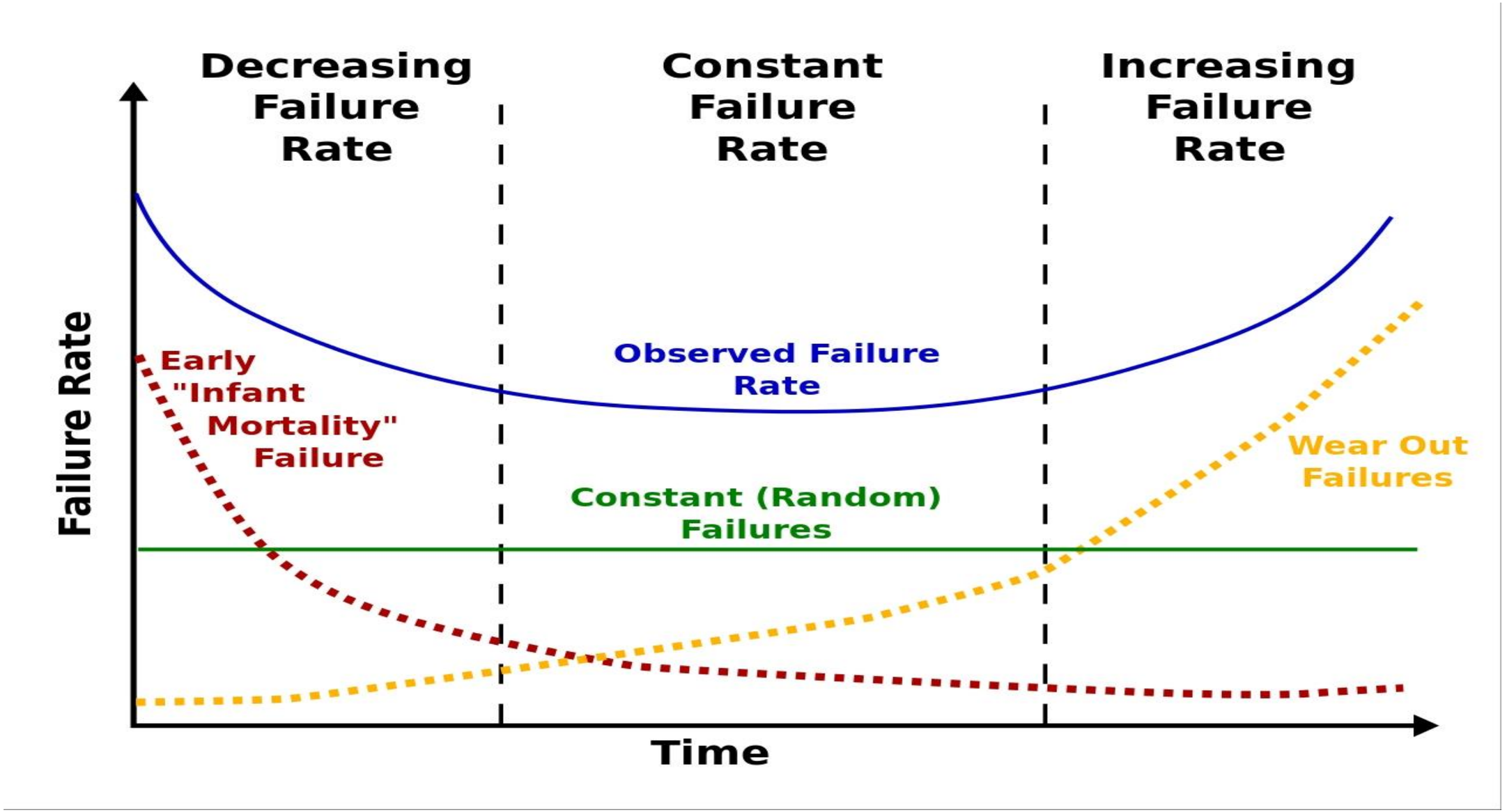
- Deficiency in design
- Improper selection of process and manufacturing technique.
- Lack of knowledge and technology
- Assembly errors
- Improper service conditions
- Less maintenance
- Variation in environment and operating conditions
- Human errors

How to minimize failures?

Failures can be minimized by

1. Margin of safety:
2. Derating
3. Redundancy
4. Durability
5. Damage tolerance (damage resistance)
6. Simplicity
7. Ease of inspection
8. Specificity

Bath tub curve



The **bathtub curve** is widely used in reliability engineering. The name is derived from the cross-sectional shape of a bath tub- steep sides and a flat bottom.

It comprises of three parts:

1. Early Failures
2. Constant random failures
3. Wear-out failures

Part-1 Early failures-

The initial stage start when a customer first begins to use the product is characterized by a high but rapidly decreasing failure rate. This region is known as the **Early Failure Period.** This phase also known as **Infant Mortality Period**.

These are eliminated by **burn in** process or **debugging**.

Warranty is based on concept of early failures.

Part-2 Constant (Random) failures-

They occur randomly and unexpectedly.

Failure rate is fairly constant. This are caused due to sudden stress beyond design limit.

This phase is called **Useful life** of the component.

The failures at this stage can be minimized by redundancy.

Part-3 Wear Out Failures-

The item is more likely to fail due to wear and tear and the number of failures will be high.

This is a typical aging problem.

Proper care and maintenance will reduce the failures at this stage.

Bath tub Curve Summary

	Phase.	Failure rates.	Possible cause	Possible improvement actions
1	**Burn-in**	**Decreasing failure rate**	Manufacturing defects, welding, soldering, assembly errors, part defects, poor QC, poor workmanship, etc	Better QC, Acceptance testing, Burn-in testing, screening, Highly Accelerated Stress Screening, etc.
2	Useful life	Constant failure rate	Environment, random loads, Human errors, chance events, 'Acts of God', etc	Excess Strength, redundancy, robust design, etc
3	Wear out	Increasing failure rate	Fatigue, Corrosion, Aging, Friction, etc.	Derating, preventive maintenance, parts replacement, better material, improved designs, technology, etc.