

**OVERVIEW OF RELIABILITY
AND
RELIABILITY CASE STUDIES**

CASE STUDIES IN RELIABILITY

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OVERVIEW OF RELIABILITY AND RELIABILITY CASE STUDIES

FAILURE

- - *Failure* is the termination of the ability of an item to perform a required function. [IEC 50]
- - Equipment *fails*, if it is no longer able to carry out its intended function under the specified operational conditions for which it was designed.

FAILURE

Failure can be any incident or condition that causes an industrial plant, manufactured product, process, material, or service to degrade or become unsuitable or unable to perform its intended function or purpose safely, reliably, and cost-effectively.

FAILURE

This implies that study of failures should include operations, behaviour, or product applications that lead to dissatisfaction, or undesirable, unexpected side effects.

PRODUCT CATEGORIES

Products can be categorised into three groups

- **Consumer durables**
- **Industrial and commercial products, and**
- **Specialised defence-related products.**

FAILURE IMPLICATIONS

- **When a *failure* occurs, no matter how benign, one feels its *impact*.**
- **When the failure is *catastrophic* (as for example, in the crash of an aircraft or the collapse of a bridge) the total economic damage and loss of life can be very dramatic, affecting society as a whole.**

FAILURE OCCURRENCE

Failures occur in an *uncertain* manner and are influenced by factors such as design, manufacture or construction, maintenance and operation.

FAILURE ELIMINATION

There is no way failures can be totally eliminated. Every engineered object is unreliable in the sense that it will fail sooner or later even with the best design, construction, maintenance and operation. What can be done is to reduce the chance of occurrence of failures within a limited time frame.

FAILURE CONTROL

This requires effective integration of good engineering with good management so that the failures and their consequences are minimised and the object can fulfil its intended purpose.

DETERIORATION

Failure is often due to the effect of *deterioration*. The deterioration process leading to a failure is a complicated process. It varies with the type of product and the material used.

FAILURE MECHANISMS

Failure mechanisms can be divided into two broad categories

- Overstress failures: brittle fracture, yield, buckling, interfacial de-adhesion etc**
- Wear-out failures: wear, corrosion, diffusion, radiation etc**

RELIABILITY

Reliability of a product (system) conveys the concept of dependability, successful operation or performance and the absence of failures. ***Unreliability*** (or lack of reliability) conveys the opposite.

RELIABILITY THEORY

Deals with the interdisciplinary use of probability, statistics and stochastic modelling, combined with engineering insights into the design and the scientific understanding of the failure mechanisms, to study the various aspects of reliability.

RELIABILITY THEORY

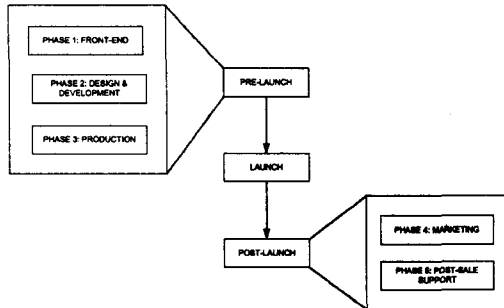
It encompasses issues such as

- **reliability modelling,**
- **reliability analysis and optimisation**
- **reliability engineering,**
- **reliability science,**
- **reliability technology and**
- **reliability management.**

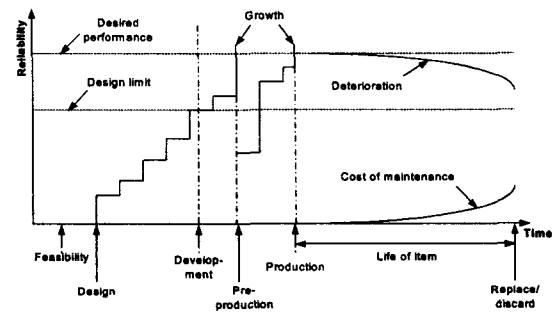
PRODUCT LIFE CYCLE

A product life cycle (for a consumer durable or an industrial product), from the point of view of the manufacturer, is the time from initial concept of the product to withdrawal of the product from the marketplace. It involves several stages.

PRODUCT LIFE CYCLE



RELIABILITY LIFE CYCLE



RELIABILITY LIFE CYCLE

The reliability of the product over the product life cycle may vary considerably but they involve various issues.

- Technical
- Operational
- Commercial
- Management

TECHNICAL ISSUES

- Understanding of deterioration and failure [Material Science]
- Effect of design on product reliability [Reliability Engineering]
- Effect of manufacturing on product reliability [Quality variations and control]
- Testing to estimate part and component reliability [Design of Experiments]

OPERATIONAL ISSUES

- **Operational strategies for unreliable systems [Operations Research]**
- **Effective maintenance [Maintenance Management]**

COMMERCIAL ISSUES

- **Cost and pricing issues [Reliability Economics]**
- **Marketing Implications [Warranties, Service Contracts]**

MANAGEMENT ISSUES

- **Administration of reliability programs [Engineering Management]**
- **Deciding on reliability issues from business viewpoint [Business Management]**
- **Risk to individuals and society due to product unreliability [Risk Theory]**
- **Effective management of these risks from a business viewpoint [Risk Management]**

MAINTENANCE

- **Corrective Maintenance: Activities performed to repair a failed equipment to an acceptable condition**
- **Preventive Maintenance: Activities performed to reduce the likelihood of failure or to achieve required performance efficiency levels**

MAINTENANCE

- **Condition Based Maintenance:** A P.M. activity that is based on the state (or condition) of the equipment.
- This requires an understanding of the degradation of the item (reliability science)

PREVENTIVE MAINTENANCE

- A variety of preventive maintenance (P.M.) actions
 - Clock based
 - Age based
 - Condition based
 - Opportunistic (Multi-Component)

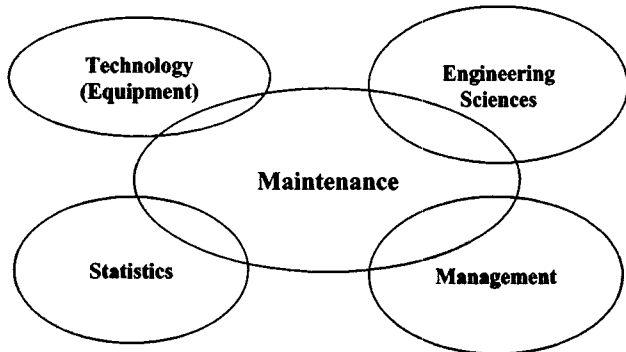
PREVENTIVE MAINTENANCE

- Cost Trade-offs
 - P.M. effort is to reduce equipment failure
 - This in turn should improve business performance
 - P.M. effort costs money
 - Trade-off between cost and improvement
- Risks
 - Failure is uncertain even with P.M. actions

EVOLUTION OF MAINTENANCE

- Maintenance concepts have changed over time.
- This topic is discussed further in a later Module
- Trend: Reactive \implies Pro-active
Technical \implies Business

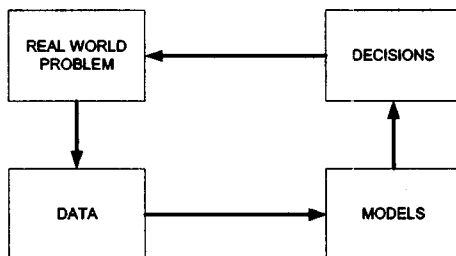
FRAMEWORK NEEDED



CASE STUDIES

- To solve real world (reliability) problems
- There can be several solutions
- Involves decision making to choose the best solution
- Models play an important role to assist in the decision making
- Data is critical for model building

CASE STUDIES



CASE STUDIES

- Case 1: Post-sale [Operation of Unreliable System; Case: Dragline]
- Case 2: Post-sale [Maintenance Service Contracts; Case: Photocopier]
- Case 3: Post-sale [Warranty Cost Analysis; Cases: (i) Aircraft Windshield and, (ii) Microwave Antennas]

HIGHLIGHTS?

- Viewing technical and commercial (or business) aspects in an integrated manner
- The role of models in decision making
- Importance of good data for model building
- Need for a interdisciplinary approach

REFERENCES

- Blischke, W.R. and Murthy, D.N.P. (2000), *Reliability*, Wiley, New York
- Blischke, W.R. and Murthy, D.N.P. (2002), *Case Studies in Reliability and Maintenance*, Wiley, New York
- Murthy, D.N.P., Xie, M. and Jiang, R. (2004), *Weibull Models*, Wiley, New York