

# CONCLUDING REMARKS



## **CASE STUDIES IN RELIABILITY**

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## **CONCLUDING REMARKS**

## **DATA COLLECTION**

- **Businesses collect lots of data**
- **The data is not always converted into information or used in decision making**
- **Need to critically evaluate the data collection process**
- **Challenge: How to collect good data in a cost effective manner?**

## **DATA ANALYSIS**

- **This is often not done properly**
- **Requires data analysts with good background in statistics and the business**
- **Qualitative versus quantitative analysis**
- **Good model building is very important for effective decision making**

## **CASE STUDIES**

- **Needed for better understanding of reliability by students in reliability programs and practitioners in industry**
- **Best written as collaborative ventures between academics and practitioners**
- **A challenge to both academics and practitioners working in reliability**

## **RELIABILITY RESEARCH**

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## **GENERAL OVERVIEW OF RELIABILITY AND RESEARCH**

### **RELIABILITY [Definition -1]**

*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 [Definition -2]**

The *reliability* of a product (system) is the probability that the product (system) will perform its intended function for a specified time period when operating under normal (or stated) environmental conditions.

## **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.**

## **RELIABILITY MODELLING**

**Reliability modelling deals with model building to obtain solutions to problems in predicting, estimating and optimising the survival or performance of an unreliable system, the impact of the unreliability, and actions to mitigate this impact.**

## **RELIABILITY ANALYSIS**

**Reliability analysis can be divided into two broad categories: (i) Qualitative and (ii) Quantitative. The former is intended to verify the various failure modes and causes that contribute to the unreliability of a product or system. The latter uses real failure data in conjunction with suitable mathematical models to produce quantitative estimates of product or system reliability.**

## RELIABILITY ENGINEERING

Reliability engineering deals with the design and construction of systems and products taking into account the unreliability of its parts and components. It also includes testing and programs to improve reliability. Good engineering results in a more reliable end product.

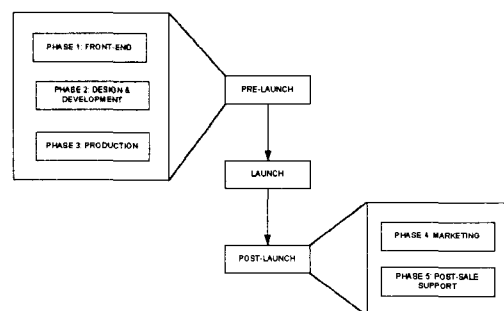
## RELIABILITY SCIENCE

Reliability science is concerned with the properties of materials and the causes for deterioration leading to part and component failures. It also deals with the effect of manufacturing processes (eg. casting, annealing) on the reliability of the part or component produced.

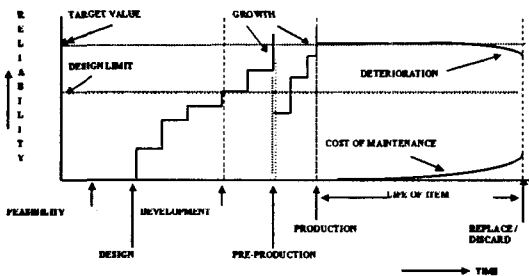
## RELIABILITY MANAGEMENT

Reliability management deals with the various management issues in the context of managing the design, manufacture and/or operation of reliable products and systems. Here the emphasis is on the business viewpoint, as unreliability has consequences in cost, time wasted, and in certain cases the welfare of an individual or even the security of a nation.

## 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]**

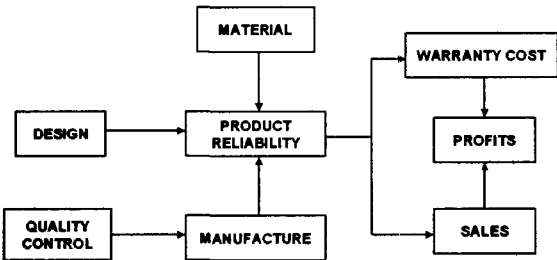
## **RELIABILITY ISSUES**

- **TWO PERSPECTIVES**
  - **Buyer (Individual, Business, Government)**
  - **Manufacturer**
- **Depends on the product**
  - **Consumer durables**
  - **Commercial & Industrial Products**

## **MANUFACTURER'S PERSPECTIVE**

- **From a manufacturer's point of view, the reliability of a product is influenced by several technical factors — design, materials, manufacturing, distribution, and so forth. Product reliability, in turn, affects the commercial side of the business — sales, warranty costs, profits.**

## PRODUCT RELIABILITY

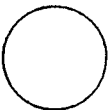


## RESEARCH

## AVAILABLE/NEW KNOWLEDGE



Available knowledge based on past research



New knowledge encompassed by new research

## RESEARCH CATEGORISATION

- Basic Research
- Pre-competitive Strategic Research
- Applied Research
- Development Research
- Industrial Research

## BASIC RESEARCH

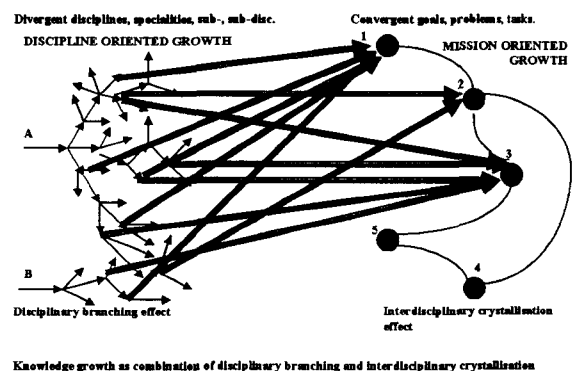
- Basic research is defined as experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, with the expectation of return in the long term form from the overall effort into basic research.

## PRE-COMPETITIVE STRATEGIC RESEARCH

- Pre-competitive strategic research is experimental or theoretical work undertaken with an applied goal ultimately in mind, but which is to be realised in the medium term. It differs from basic research in terms of research objectives and time frame and usually aims to help secure medium-term competitive advantages.

## APPLIED RESEARCH

- Applied research is defined as work carried out for the advancement of knowledge with a specific practical application in view and with the expectation that the research results will be of value in the short to medium term.



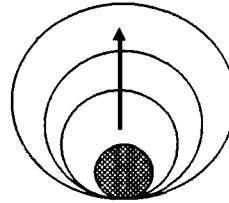
## RESEARCH STRATEGIES

[Reisman (1988)]

For generating new knowledge

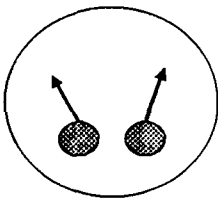
- **Ripple**
- **Embedding**
- **Bridging**
- **Transfer of technology**
- **Creative application**
- **Structuring**
- **Statistical modelling**

## RIPPLE PROCESS



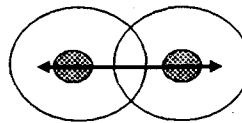
An extension of previous theoretical or applied type of research in a given discipline or sub-discipline.

## THE EMBEDDING PROCESS



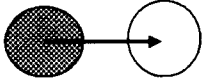
The development of more generalised formulation or a more global theory by embedding several known models or theories.

## THE BRIDGING PROCESS



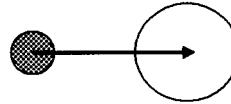
The bridging of known models or theories resulting from the growth of the contributing and/or some initially unrelated field of knowledge.

## TRANSFER OF TECHNOLOGY



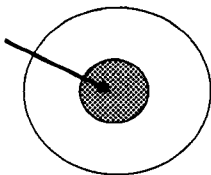
The use of what is known in one discipline to model problem domains falling in some other, perhaps disparate, discipline.

## THE CREATIVE APPLICATION PROCESS



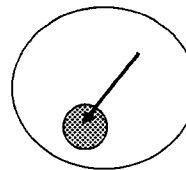
The direct (*not analogous*) application of a known methodology to a problem or research question that was not previously so addressed.

## THE STRUCTURING PROCESS



The process of organisation and documentation of the organisational phenomena in the form of models.

## THE STATISTICAL MODELLING PROCESS

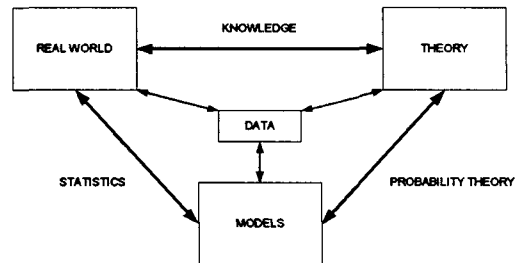


Models that arise from analyses performed on empirically obtained data. These models arise from statistical manipulations such as regression or cluster analysis rather than on logical derivations based on various assumptions.

## RELIABILITY RESEARCH

- **Extend the knowledge** (science, techniques, methodologies etc)
- **Narrow the gap between theory and application** (different industry sectors)
- **Scope** (narrow to broad)
- **Qualitative** (understand) or **quantitative** (to predict)

## MAIN ELEMENTS



## SOME SPECIFIC TOPICS

### Pre-launch Stage

- **Topic 1: Reliability in Design and Development**

### Post-launch Stage

- **Topic 2: Maintenance**
- **Topic 3: Product Warranty**