ESSENTIAL ELEMENTS OF GREAT MAINTENANCE

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WINE ENGINEERING CONFERENCE JUNE 2011
NURIOOTPA

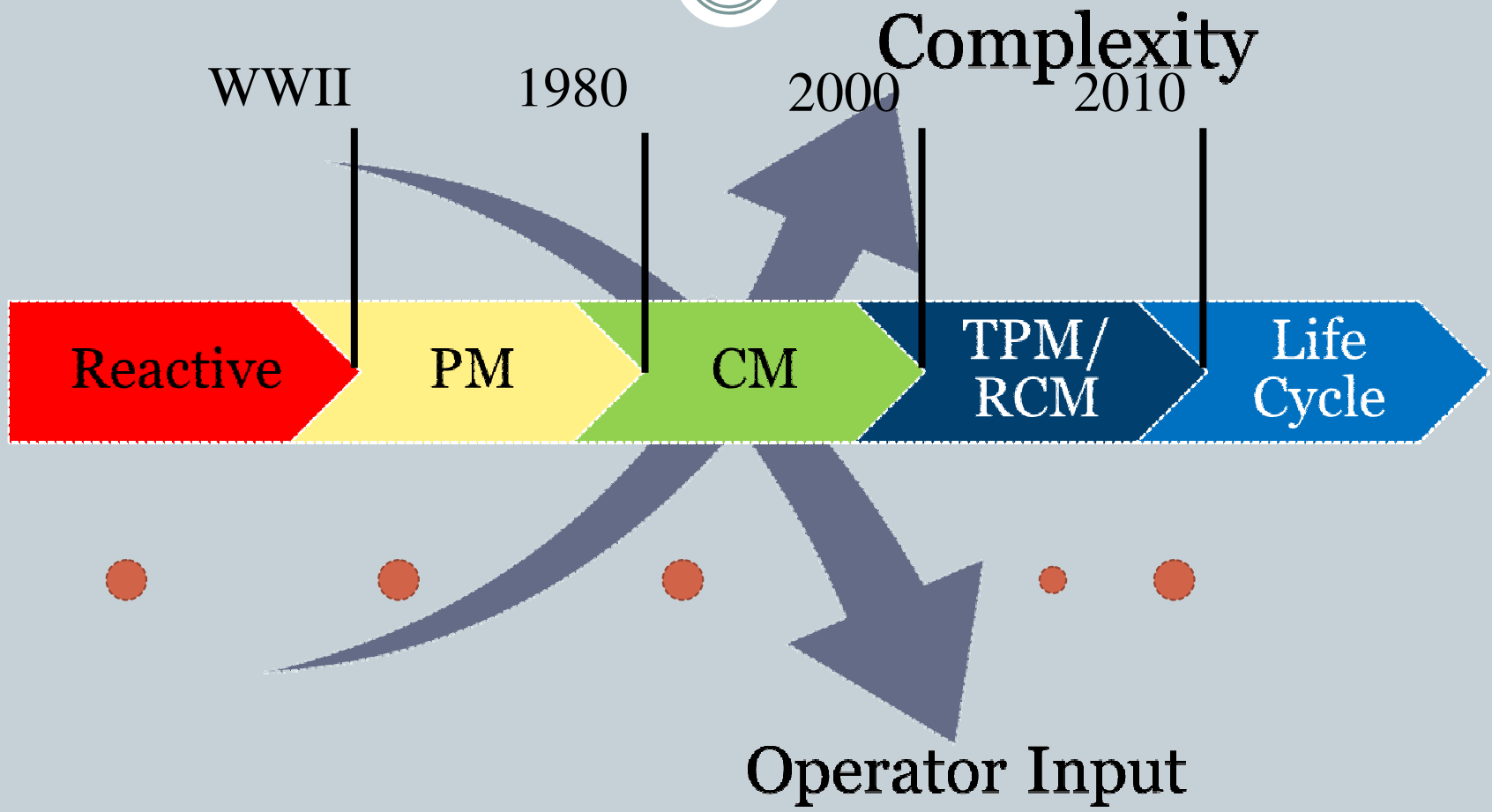
Agenda

- Reliability background
- Reliability History
- Reliability Principles
- Failure Theory
- Best Practice Maintenance

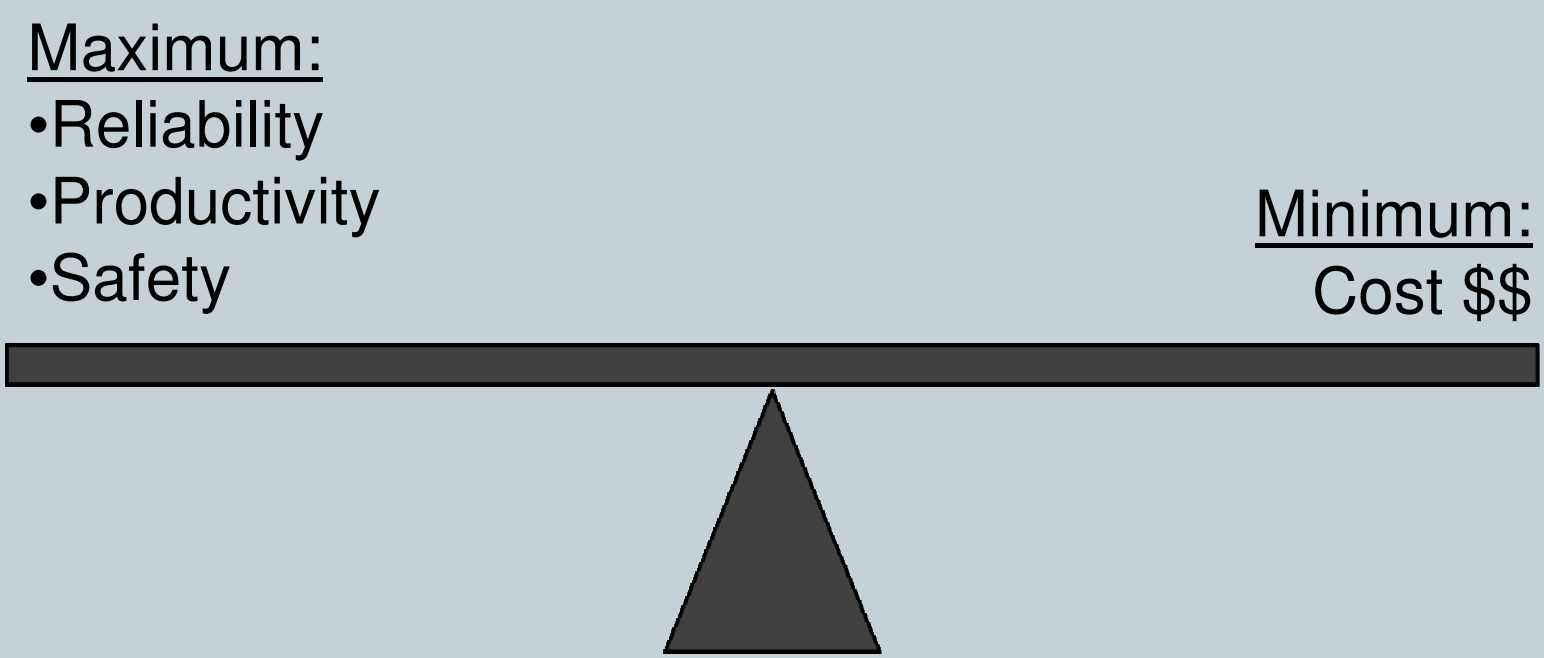
Reliability Background

Maintenance = Confusing terminology

Reliability History

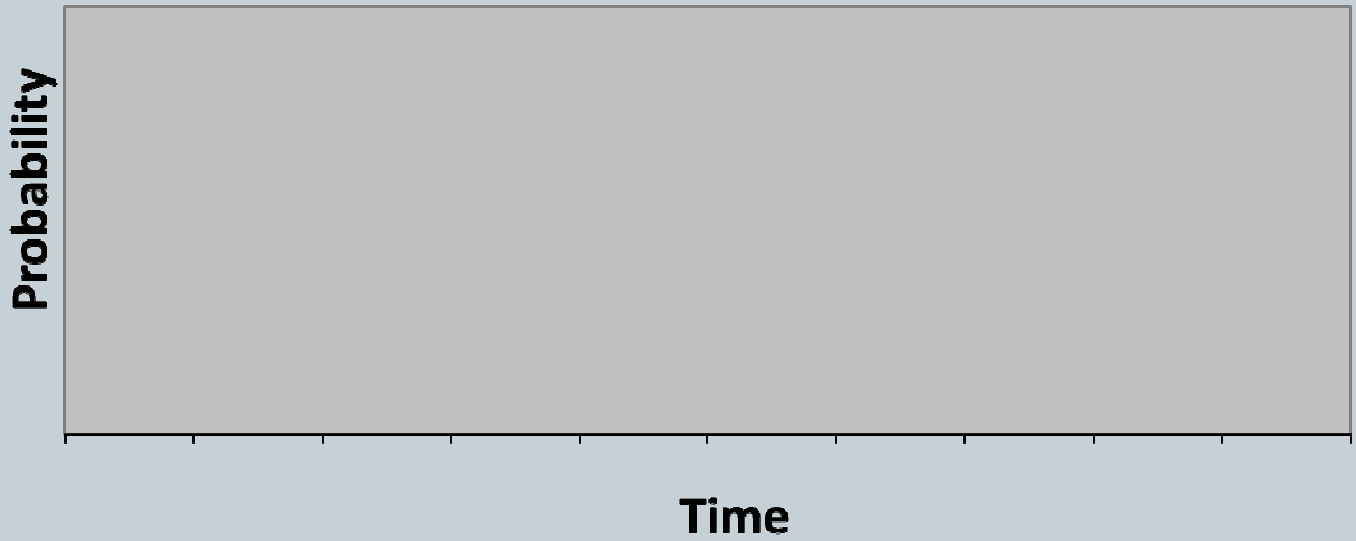


Reliability Principles



Failure Theory

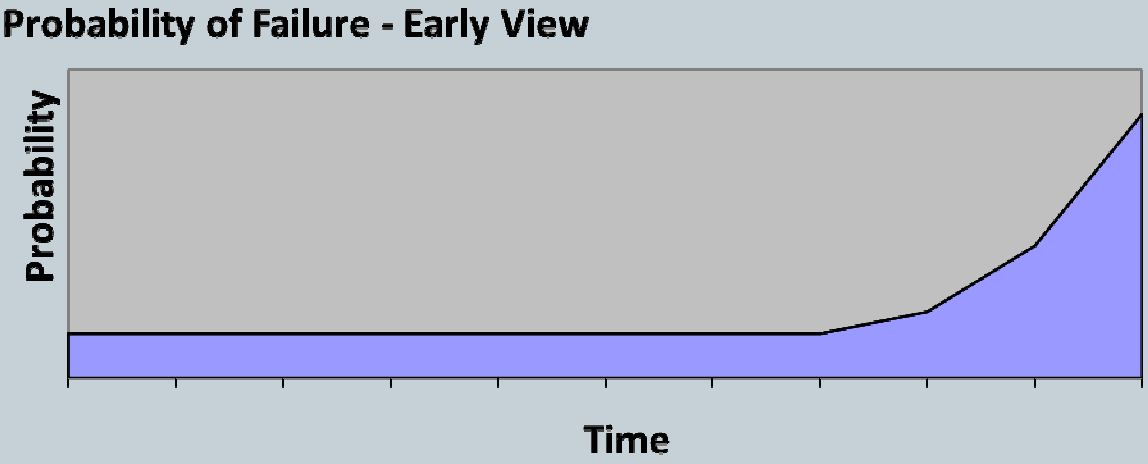
Exercise Plot Risk of Failure against Time



Failure Theory

Traditional View of Failure

In the age of simple machines and simple analysis techniques, the probability of failure versus time was thought to look like this:



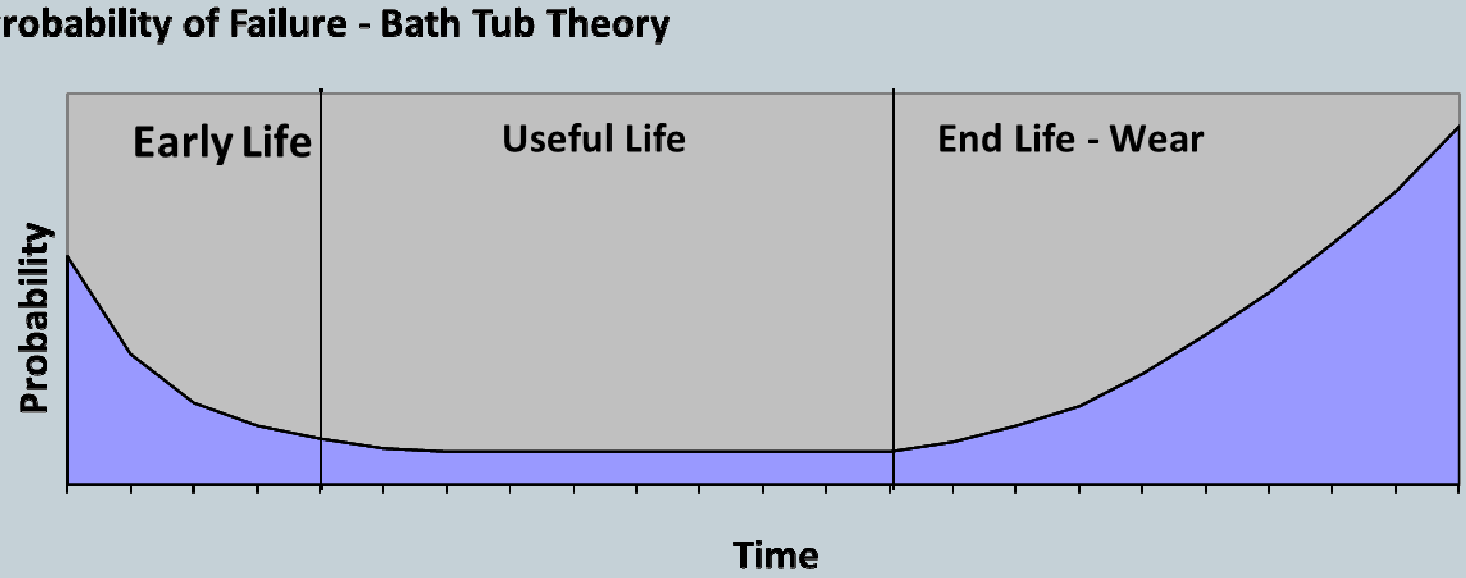
Fits with our expectations for equipment.

Good run and expected “End of Life” phase.

Failure Theory

Bath Tub Theory:

During the 1950's and 60's observation lead to the view that the failure rate curve actually looks like:



Failure Theory

Bath Tub Theory:

•This is the commonly discussed bath tub theory of failure. ***Early life*** failures are observed and are thought to be caused by installation, design, human or system errors. These are fixed during the "commissioning" period either for a new installation or after an overhaul.

•After this time the ***useful life*** period starts where the equipment has stable and random failure rate.

•Then at some point in time the equipment enters the ***end life*** period where it starts to wear out causing an ever increasing failure rate.

"Weibull Analysis"

Failure Theory

Failure Theory Revolution – 6 patterns not 1

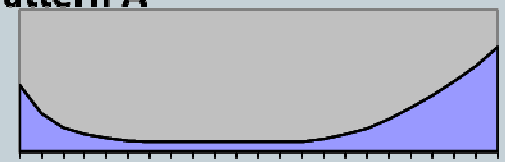
During the 1960's and 70's Nowlan and Heap (1) (United Airlines) studied the failure pattern of numerous mechanical, electrical and structural components over a number of years.

This culminated in a publication in 1978 titled "Reliability Centred Maintenance" prepared for the US Department of Defence.

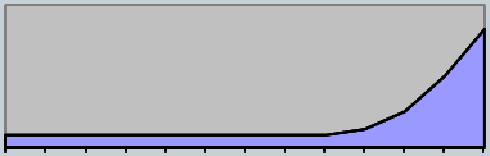
Failure Theory

Failure Theory Revolution – 6 patterns not 1

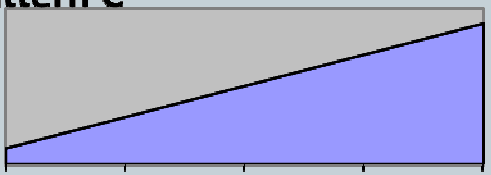
Pattern A



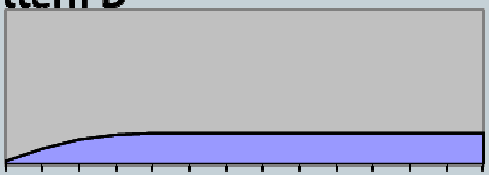
Pattern B



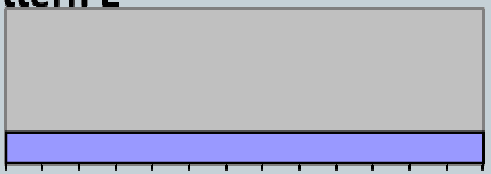
Pattern C



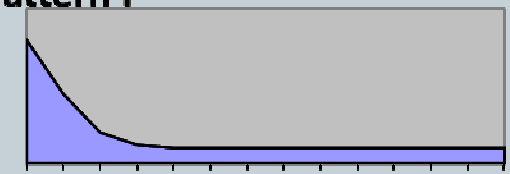
Pattern D



Pattern E



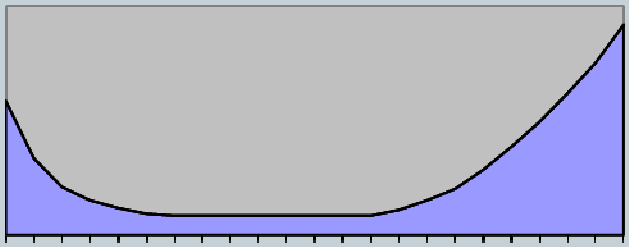
Pattern F



Failure Theory

A Bath Tub

Pattern A



4% of failures

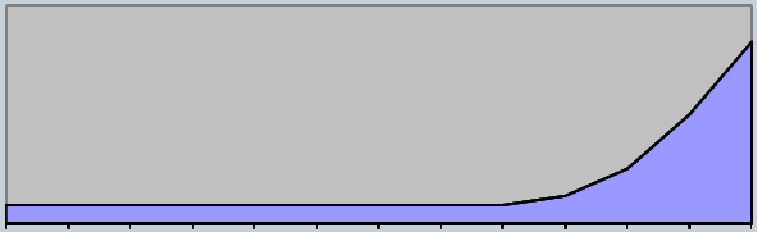
Example: Older electromechanical device requiring setup and calibration and then wear.

(Carton Erectors??)

Failure Theory

B – Wear-Out Zone

Pattern B



2% of failures

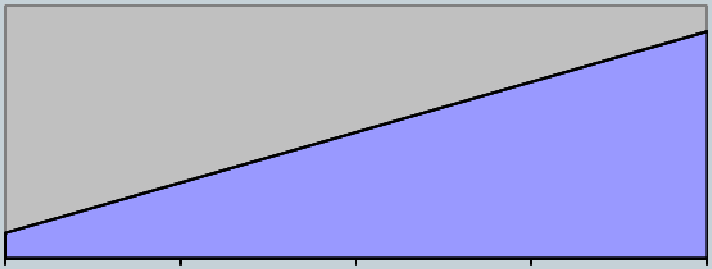
Example: Jet engine blades – fatigue

(Filler Rubber Seals)

Failure Theory

C – Slow Ageing

Pattern C



5% of failures

Example: Wear in hydraulic system when contamination present; roller wear; heat damage; UV damage

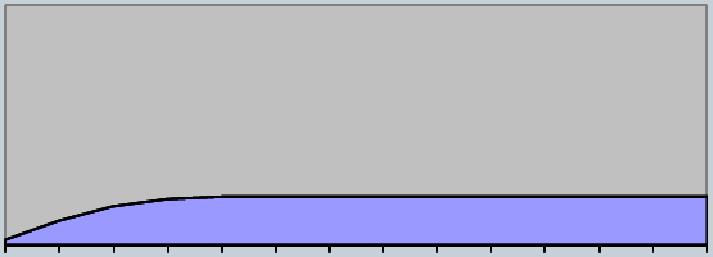
Pasteuriser Valves??

Failures types **A – C** are characterised by an increased end of life increase in failure rate. **Total of 11%.**

Failure Theory

D – Initial Break In

Pattern D



7% of failures

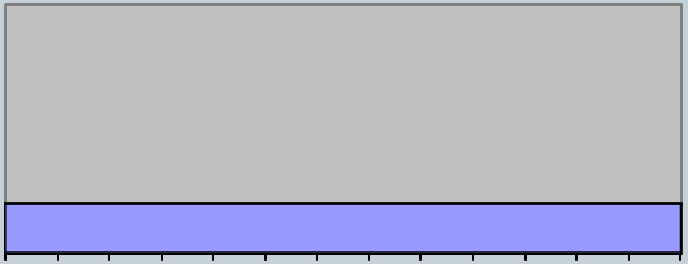
Example: Wool combing equipment with a number of components of type C.
Or wear lubrication, cleaning or environmental factors are not well managed.

Filler as a whole??

Failure Theory

E – Random

Pattern E



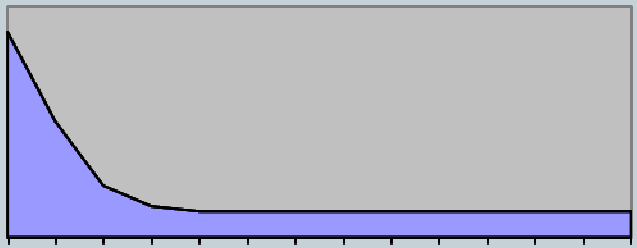
14% of failures

Example: Electronic components; consistently maintained systems. Bearings installed correctly and not overloaded.

Failure Theory

F – High Infant Mortality

Pattern F



68% of failures

Example: Human factors, design issues, manufacturing issues etc

Failures types **D – F** are characterised by an increased end of life increase in failure rate. **Total of 89%.**

Failure Theory

Progress on Failure

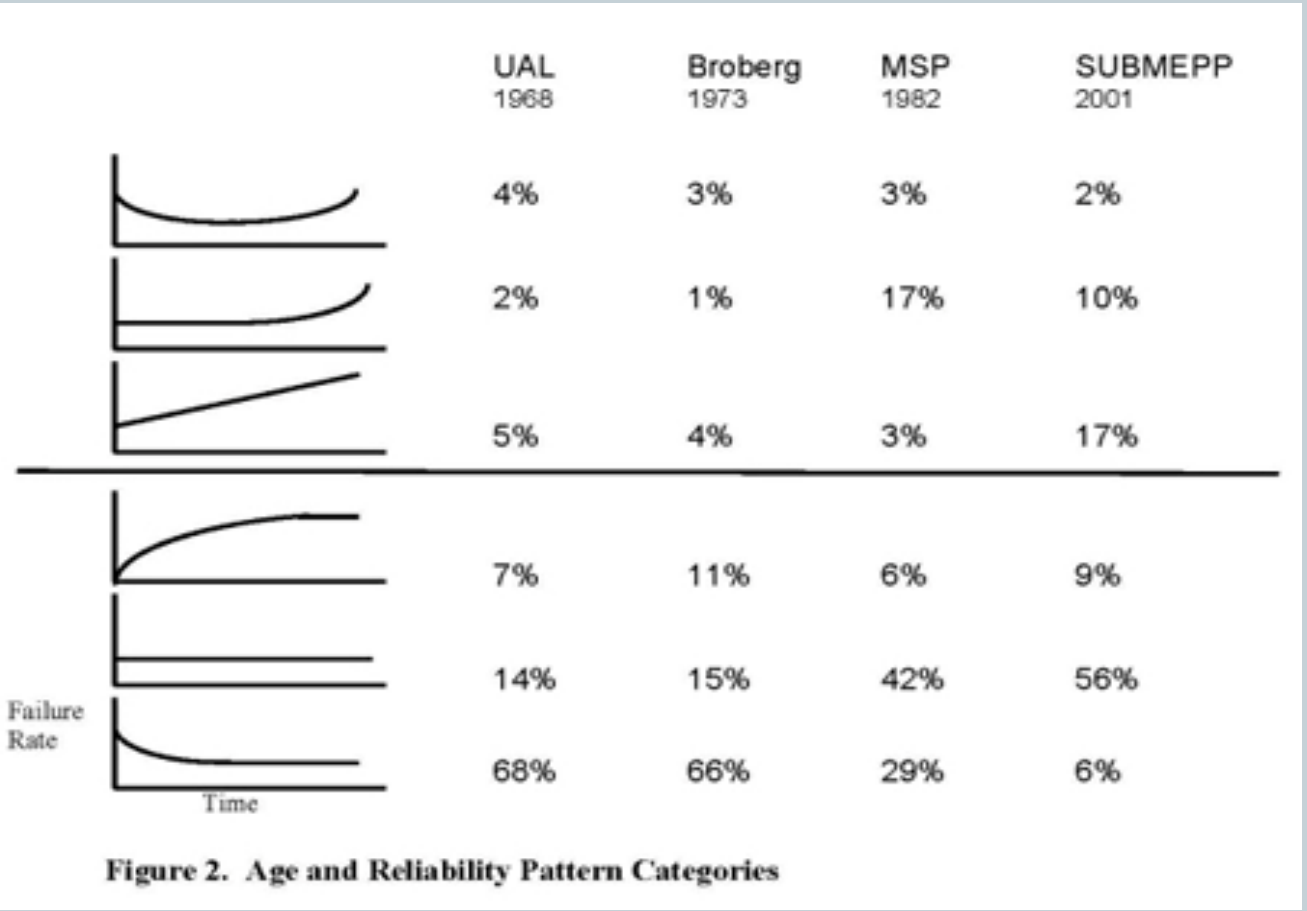


Figure 2. Age and Reliability Pattern Categories

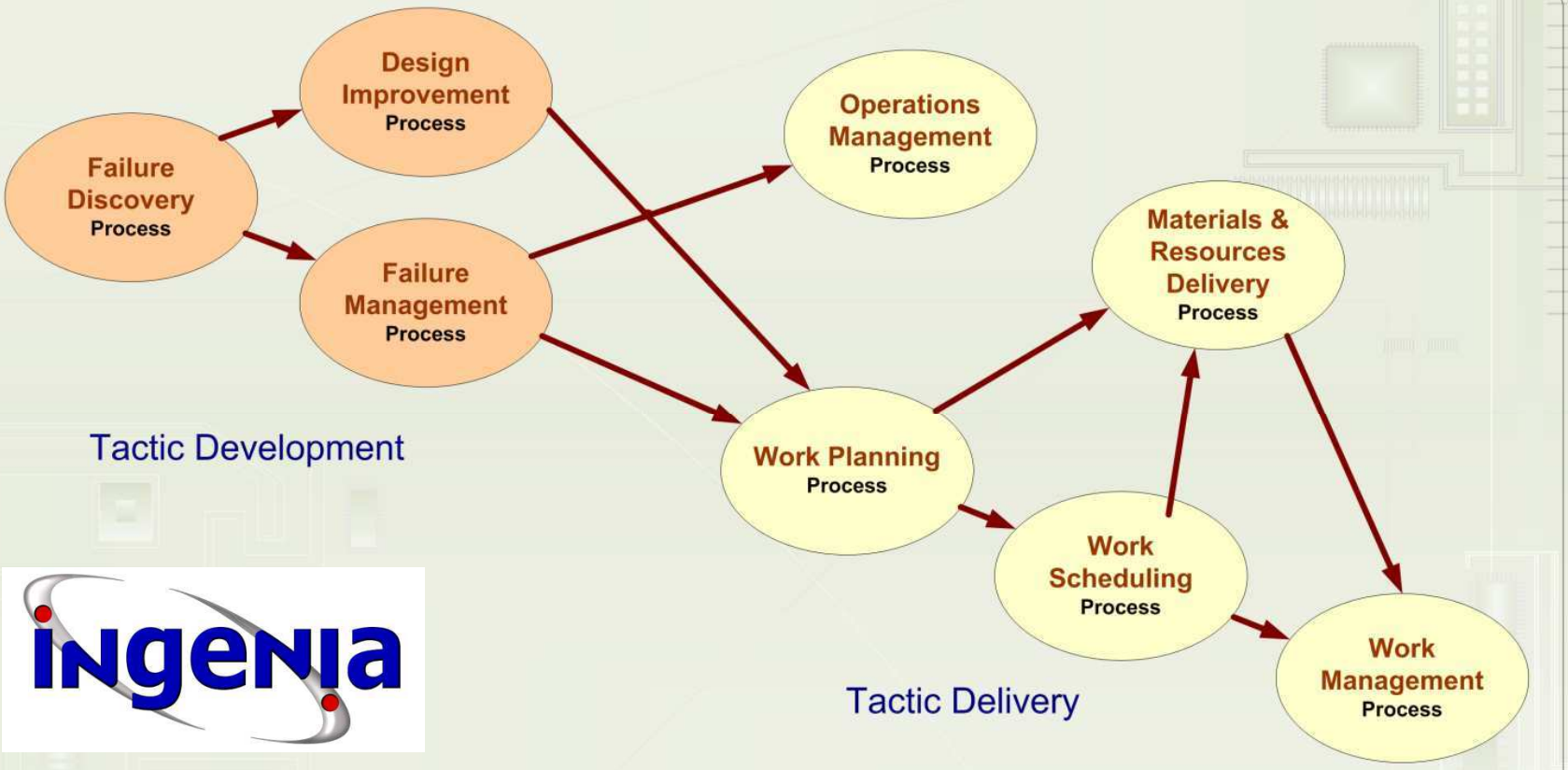
Reliability Principles

The essential elements of great Maintenance:

- Identify why and how the equipment fails.
- Assess the consequences of the failure and prioritise the development of tactics to minimise the consequences.
- Select the tactic that best manages the failure – Preventative, Predictive or Reactive.
- Set up work schedules to deliver these tactics efficiently.
- Develop good disciplines for planning and scheduling work and resources to complete the work.
- Measure the effectiveness of the program and adjust as required

Simplified Asset Management Model © Ingenia 2009

Monday, October 05, 2009



Performance Measurement Process

Safety Management Process

Skills & Training Management Process

Conclusion

- Questions??

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Definitions

- PM = Preventative maintenance = servicing program.
- TPM= Total productive maintenance = complete system of plant care that seeks to maximise performance and minimise reject.
- CM = Condition monitoring = measurement of condition eg temp, vibration, etc. Sometimes called PdM – Predictive Maintenance
- CMMS = Computerised maintenance management system = Computer system to manage maintenance work - Mainpac.
- RCM = reliability centred maintenance = process of defining maintenance strategy based on consequence of failure.
- RCA = Root cause analysis = process to find the true causes of failure.
- R&M = Repairs and maintenance = term to identify maintenance cost.

Definitions

- MTBF = Mean time between failure (days) = Ave time between failures on a machine or process (failure rate).
- OEE = Overall equipment effectiveness = measure of available time x run rate performance x reject performance.
- Planning = the process of organising people and material resources and methods for a job.
- Proactive task = a task that is aimed at maintaining or improving reliability (may not be well planned though).
- Reactive task = a task forced to be completed by a breakdown or defect.
- Scheduling = the process of deciding when a job can be completed.

Predictive Maintenance

What is Predictive Maintenance (PdM) or Condition Monitoring (CM)

Predictive maintenance is the use of some kind of measure to predict the failure of equipment. It implies that:

- The measurement can be analysed to determine the condition of the equipment
- The equipment fails in a predictable way according to the measure
- The measurement can be taken in a cost effective process

Predictive Maintenance

Examples of measurements commonly used for CM are:

- Vibration – mainly for rotating machines but also for structures
- Temperature – motors, switch boards, electrical connections, cement kilns etc
- Pressure – dust collectors, tyres, etc
- Contamination – oil debris, etc
- Viscosity – oil quality
- Wear – mill rollers, liners etc

Predictive Maintenance

It will be immediately obvious that CM is not really a new idea as measurements have always used to detect the condition of equipment either formally or informally.

The development of CM techniques is increasingly important as equipment has become more:

- Complex (harder for people to immediately understand)
- Guarded (harder to see moving parts)
- Automated (less people around the equipment listening and monitoring) It will be immediately obvious that CM is not really a new idea as measurements have always used to detect the condition of equipment either formally or informally.