
Through-life management of engineering assets

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Agenda

- ◆ Impact of information availability on maintenance decisions
- ◆ Analytical models supporting optimal inspection / maintenance planning
- ◆ Capability requirements planning and its links to maintenance management
- ◆ Wrap-up and discussion

Impact of information availability on maintenance decisions

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Problem

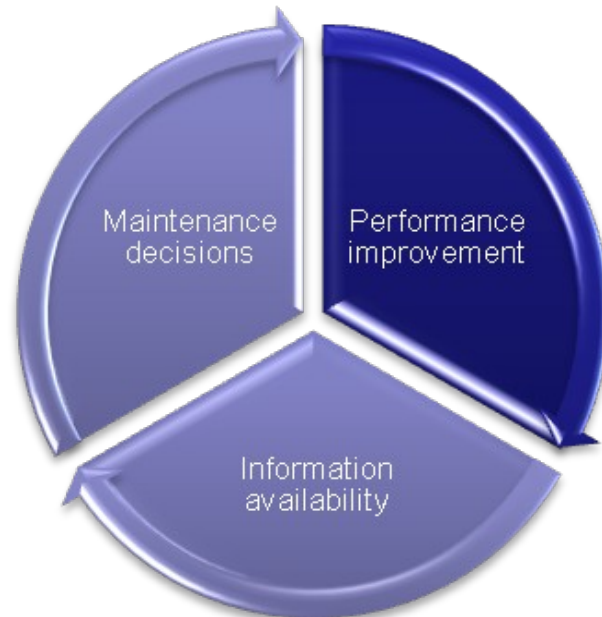
What is the condition of my asset? Do I need more information?

Should I inspect?

If yes, when should I?

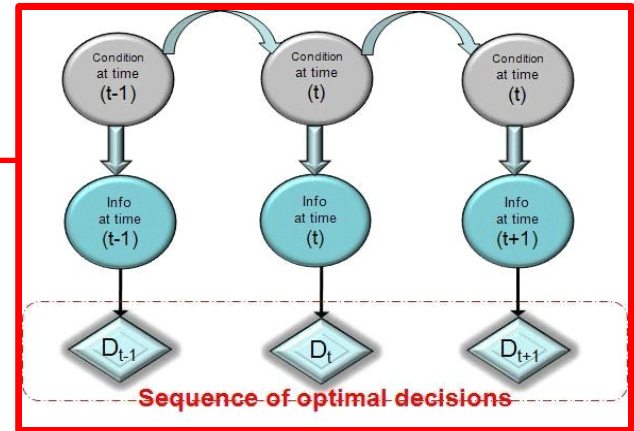
What are the alternative inspection techniques I can choose from?

How can I quantify which of these techniques is more valuable to my organisation?



Approach

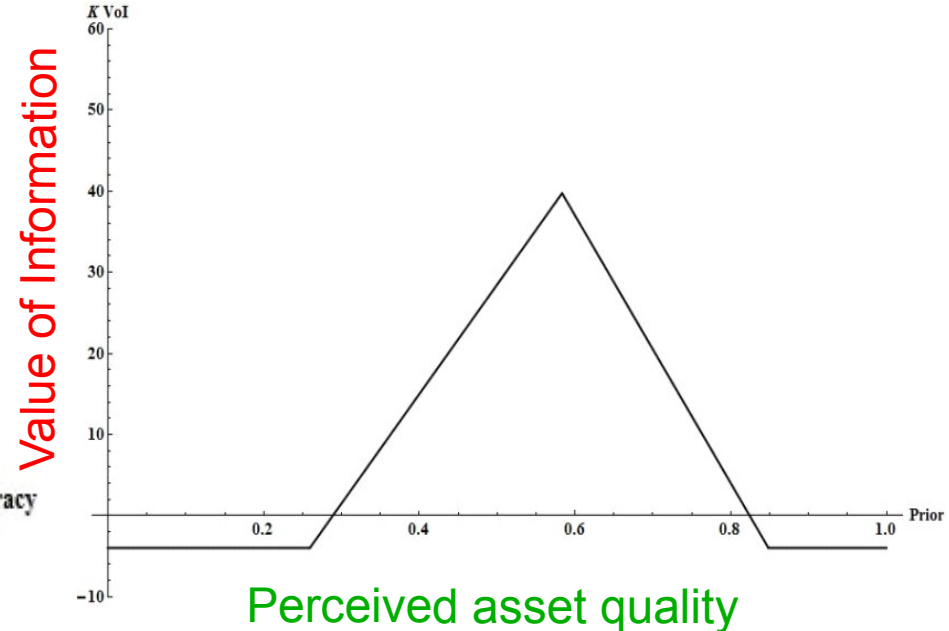
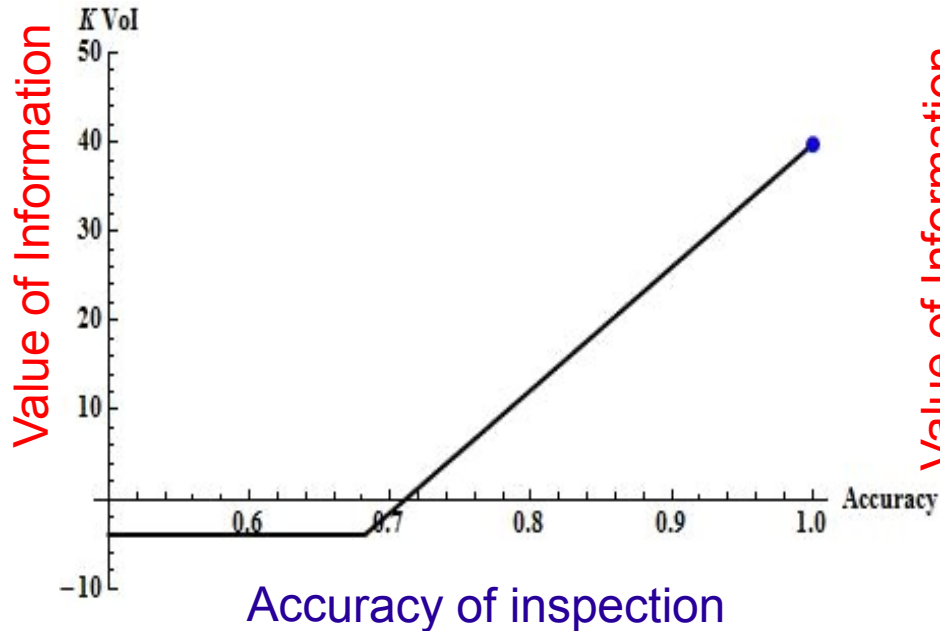
- Sequential decision making
 - finite planning horizon
 - discrete time periods



- **Partially-Observable Semi-Markov Process (POSMDP)**
 - The asset state (condition) is not known for sure
 - Examples of asset states: good, degrading, failed
 - Realistic assumptions on asset degradation rates
 - Example: Non-exponential *sojourn times*
- Decisions supported (when & how):
 - Inspections
 - Minor/major maintenance
 - Replacement

Results

- Optimal maintenance policy derived based on information availability



Analytical models supporting condition based maintenance

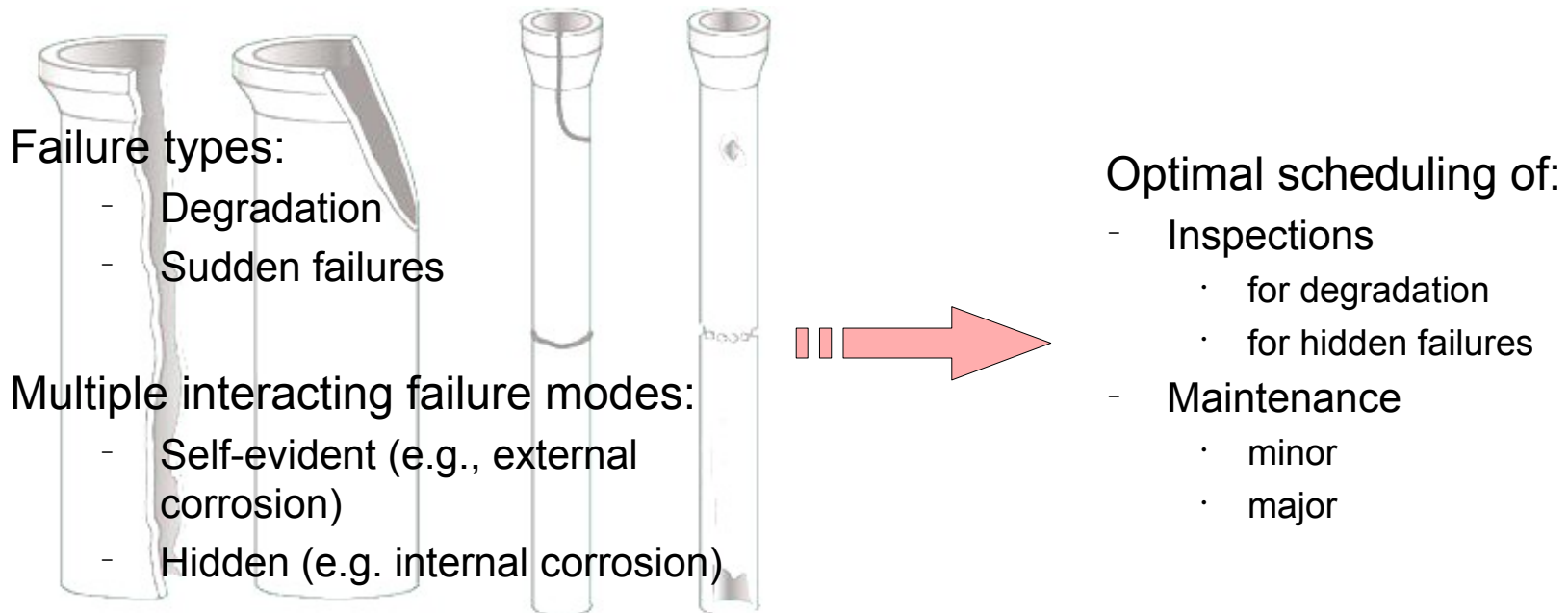
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Problem

Purely analytical methods in maintenance modelling are too often unrealistic. However there are significant benefits with respect to purely numerical approaches.

“ How can we develop analytical methods in maintenance management that are **realistic** and **useful** ?”



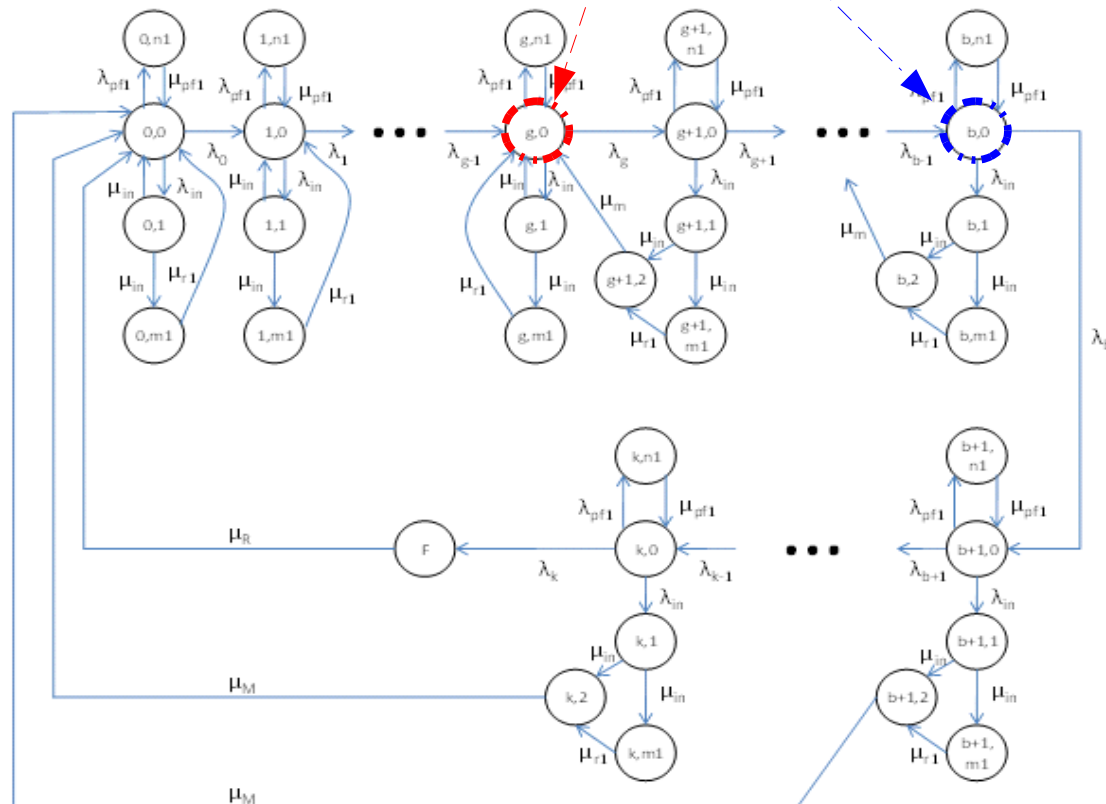
Approach

Asset

- One degradation mechanism
- Multiple sudden failures
 - Self-evident
 - **Hidden**

Decisions

- Mean Time Between Inspections
- Minimal maintenance threshold
- Major maintenance threshold



Results

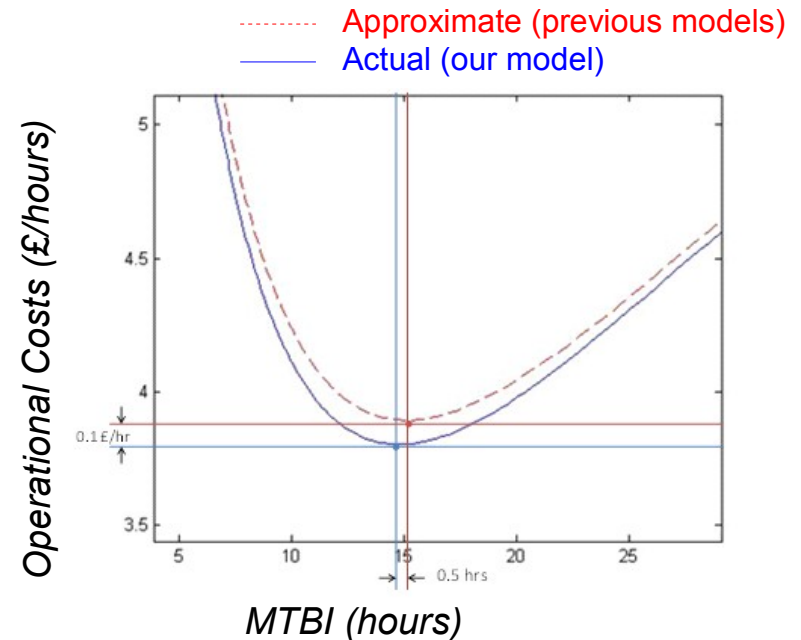
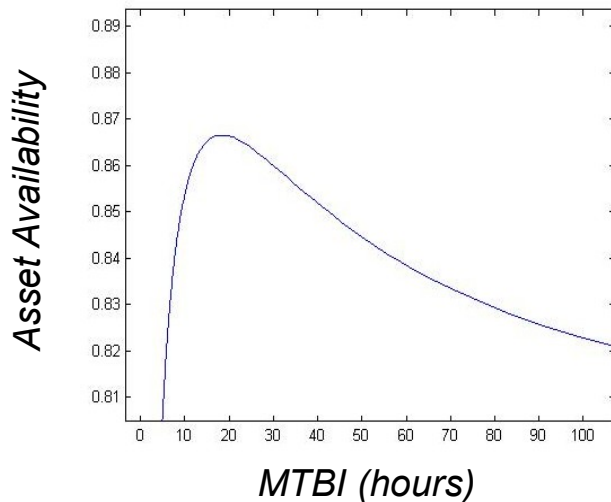
◆ Closed-form analytical solutions

★ Easy computation of many asset performance measures

➔ Availability

➔ Mean Time To Failure

➔ Operational Costs



★ Simplified optimization of the same quantities

★ Better understanding of the problem structural characteristics

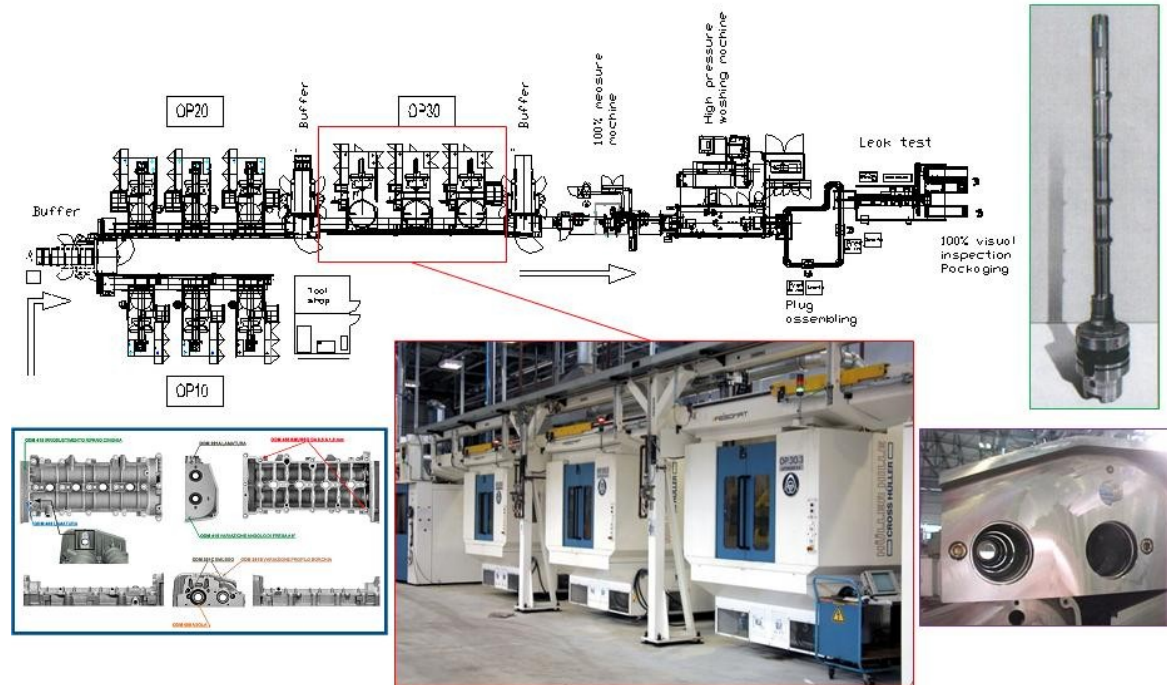
Optimal long-term capability and capacity planning of engineering assets

Dr Maurizio Tomasella

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Problem

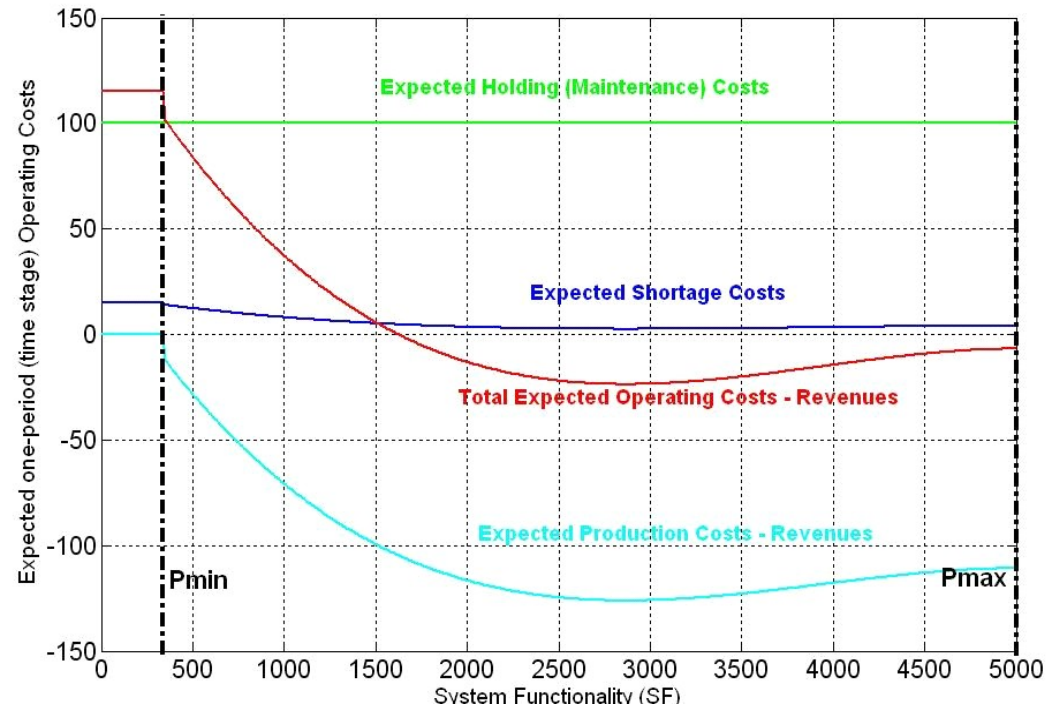
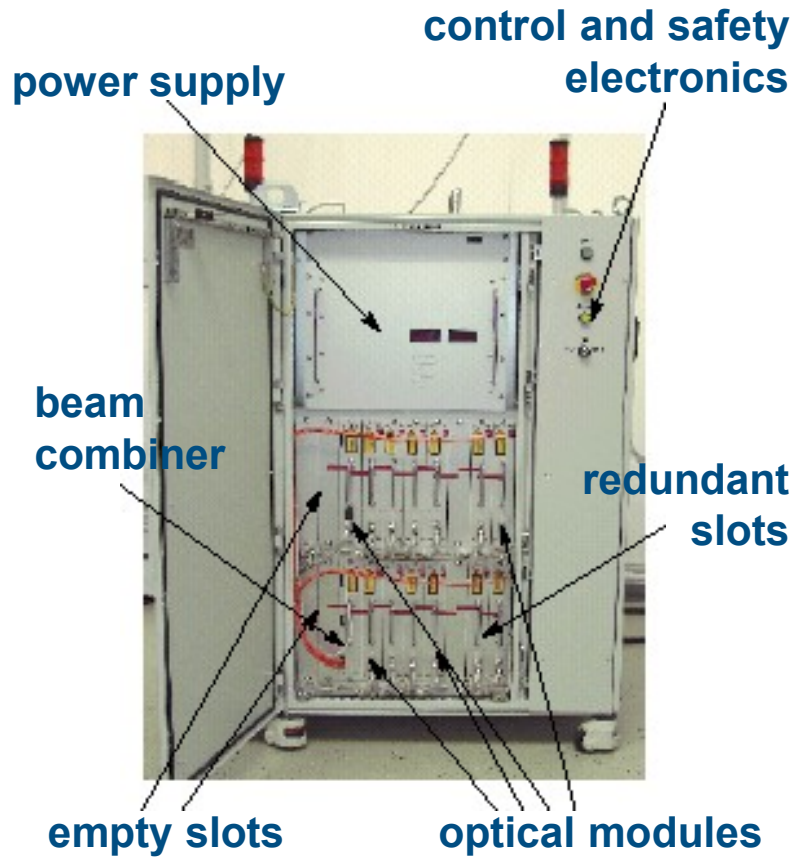
Frequently changing and highly uncertain market requirements might jeopardize the profitability of any asset-intensive organisation, if the capability installed is not matching, over time, the evolution of the market capability requirements



Approach

- ◆ A model of asset capability requirements planning
 - ★ Focus on asset configuration/reconfiguration sequential decisions
 - (Completely Observable) Markov Decision Process (MDP)
 - ★ Financial view (CAPEX/OPEX)
 - Time value of money
 - Depreciation
 - Tax effects
 - ★ Acquisition costs / **Renewal costs** / Salvage value
 - ★ Operating Costs
 - Utilisation costs
 - **Ramp-up costs**
 - Shortage costs
 - **Maintenance costs**
 - **Inspection costs**
 - **Repair costs**

Case example



Wrap-up and discussion

Help us to help you...

We can help you...

1. By restricting our attention to:

- ★ Simple models (i.e. small number of unknown parameters)
- ★ Approximate solutions to problems of interest to decision-makers.

2. By investing more efforts working with your engineers and managers:

- ★ In the collection of **data** relating to problems of interest.

where data is

- **not just** specific figures relating to failure time, etc.
- **but also** all relevant information relating to the process of interest.

Note: It is often the latter, rather than the former, that prove most enlightening !!!

You can help us...

- By supporting point 2 above

Your benefits...

- Improving your processes and decisions based on sound foundations
- Early implementation of research output

Thank you for your time