First International Conference on Engineering Failure Analysis

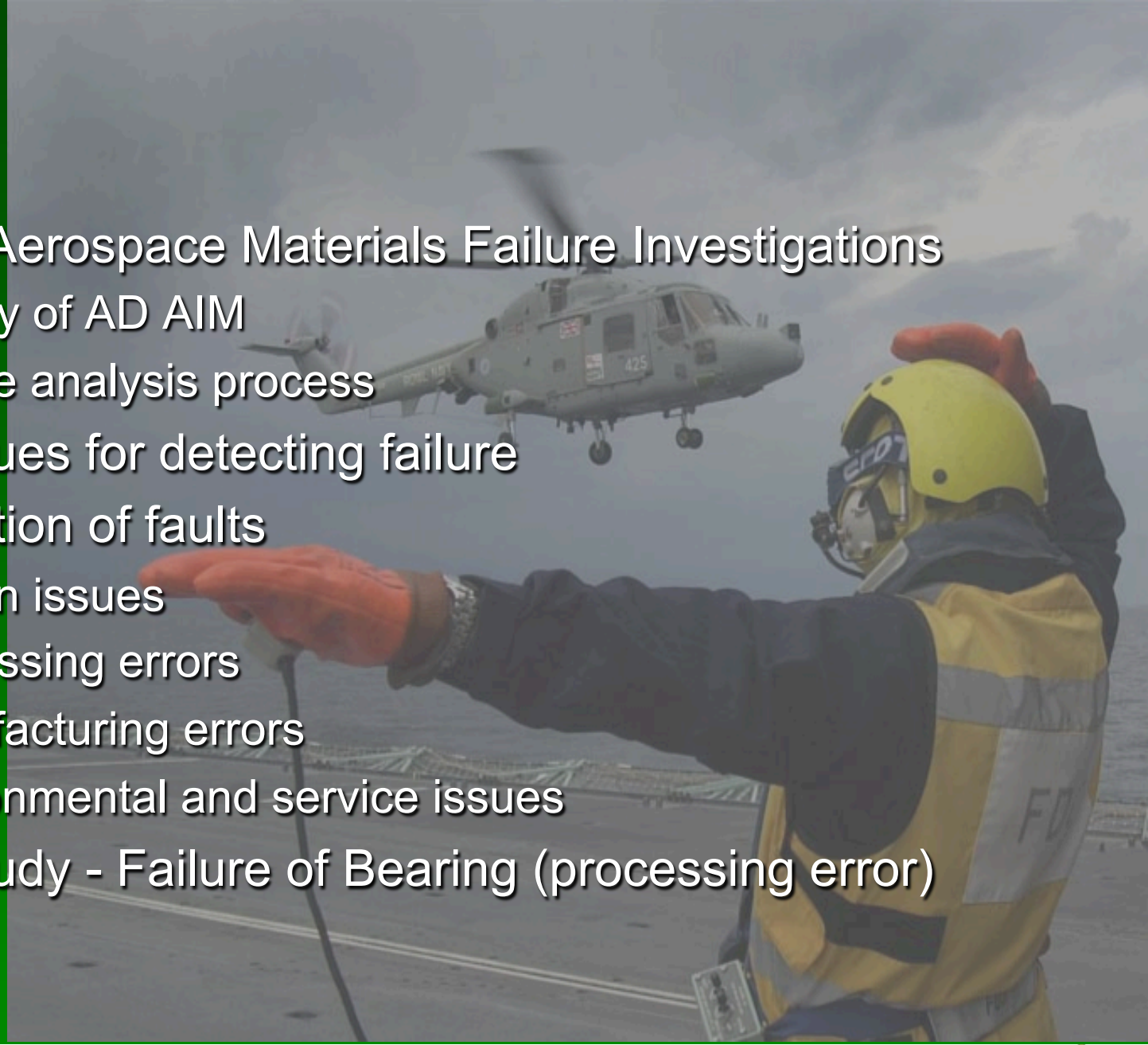
Military Helicopters: Have the seeds of future accidents already been sown?

Dr Nicola Symonds *
Dr Cheryll Pitt

Aircraft Materials Evaluation Group
AD AIM

12-14 July 2004 Lisbon, Portugal

Contents



- Military Aerospace Materials Failure Investigations
  - History of AD AIM
  - Failure analysis process
- Techniques for detecting failure
- Introduction of faults
  - Design issues
  - Processing errors
  - Manufacturing errors
  - environmental and service issues
- Case Study - Failure of Bearing (processing error)

A Brief History of AD AIM

- Established in 1945 as Naval Aircraft Materials Laboratory
  - Investigate chemical and metallurgical problems
  - Advise on new materials and processes
  - Assist with Accident Investigations

A Brief History of AD AIM

- Today AD AIM has expanded into a greater role
- Work with all branches of the forces: RAF, NAVY & ARMY
- Failure investigations
- Air crash investigations
- Aircraft Integrity Monitoring
  - Non Destructive Testing
  - Fuels monitoring
  - Wear Debris Analysis
  - Health and Usage Monitoring Systems

The Failure Analysis Process

- A common question from a military customer: -

"Should my aircraft Fleet be grounded as a result of this failure?"

- Wide reaching implications
- Determining the failure mode is not the end of the story
- Prevention of future occurrences is a priority
  - Service environment- maintenance schedules
  - Operational needs

The Failure Analysis Process

- Failure: Inability of a part or assembly to perform its intended function.

- A common question from a military customer: -

"Should my aircraft Fleet be grounded as a result of this failure?"

- Wide reaching implications - flight safety

The Failure Analysis Process - Initial work

- Understand your failed component
  - Specifications
    - materials and manufacturing route
  - Drawings
  - Look at whole one, in situ
- Understand its usage
  - Designed usage and real usage
- Understand its history
  - Environmental (marine, desert etc)
  - maintenance

Root Cause

- Solutions to prevent reoccurrence of problems cannot be developed without identification of the root cause

Quotes

- You can't wait for inspiration. You have to go after it with a club.
  - Jack London (1876 - 1916)
- Genius is one per cent inspiration, ninety-nine per cent perspiration.
  - Thomas A. Edison (1847 - 1931),

The Modern Military Helicopter

The Modern Military Helicopter - Operational Success

- Versatile, rapidly deployable vehicle
- Work-horse for moving men and loads
- Multi-role, multi-environment:
  - Sea air rescue
  - Utility, battlefield support
  - Attack
  - Anti-submarine warfare
  - Anti-surface warfare
  - Airborne early warning
  - Casualty evacuation

The Modern Military Helicopter - Mechanical nightmare

- Deployed into corrosive, erosive, wet or hot environments
- Limited redundancy often only one load path
- Rotating highly loaded components
- Vibrations pass through the structure
- Novel aerospace materials
- Varied types of materials and components
- Multiple modifications - unique configurations
- Hand made
- Unpredictable flying/ loading regimes

Case Study: Chinook Bearing Failure

- Tribological failure investigation of a roller bearing
- Part of a rejected gearbox within a RAF Chinook
- Rejected due to an increasing vibration trend.
- Aims of investigation
  - Understand the cause, prevent re-occurrence
  - Interpret vibration data in terms of physical cause

Conclusions

- Examination of a HUMS rejected bearing revealed serious surface distress after only completing 33% of its service life.
- The bearing displayed evidence consistent with the final stages of life. And therefore the transmission was saved by removal of the CB1 bearing.
- By thoroughly inspecting the damage mechanism a greater understanding of bearing failure mechanisms has been reached.
- This understanding has allowed informed decisions to be made when setting HUMS automated threshold alerts to facilitate early detection and accurate diagnosis of transmission faults through vibration analysis.