Structural Health Monitoring
Daedalus to Delta wing: engineering safer aircraft
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Overview

• Background on aircraft structural damage
• Causes of structural damage
• Structural Health Monitoring
• Developments at Cardiff University
The requirement of the aircraft
1953-1954 – DH108 Comet
1988 – Boeing 737-200

737-100/-200 (“Classic”) Early Design 292 airplanes

737-300 through -500 (“Classic”) Modified Design Over 2800 airplanes

737-700 through -900 (“Next Generation”) Over 4800 airplanes
Sources of Damage
Structural Health Monitoring
Structural Health Monitoring

Sensor Network

Ouch! My Wing!
The Detection Problem

• What size of damage do we want to detect?
• What level of locational accuracy?
• What types of damage do we want to detect?
• Monitor the global structure or local areas?
• How many sensors are needed and where to put them?
• What material do we want to detect damage in?
• Active or Passive?
A wealth of Engineering technologies

• Fibre Bragg gratings

• Measures changes in strain
• Local damage detection
A wealth of Engineering technologies

- **Eddy current foil sensors**
  - For detecting cracks in metallic structures
  - Can be mounted on interfaces of structural parts
  - Ideal for monitoring structural health in hard-to-reach places
A wealth of Engineering technologies

- **Acousto-Ultrasonics**

- **Active monitoring system**
- Uses ultrasonic surface waves
- Can globally monitor the structure
A wealth of Engineering technologies

• Acoustic Emission
  
  Signal Detection
  
  Signal Processing
  
  Signal Display

• Passive technique
• Can globally monitor the structure
Developments at Cardiff University
Acousto-Ultrasonics
Laser Vibrometry

- Uses the Doppler Effect to measure vibrations
- Non-contact
- High resolution
- Infinite Bandwidth
- Can measure wave propagation in all three planes
Composite wind turbine blade BVID interaction
‘Holey Plate’ results

Traditional TOA Method

Experimental Trained Delta-T

LISA Trained Delta-T
Wireless sensor networks

\[ \frac{\Delta T_{12}}{\Delta T_{23}} \propto \text{Bearing} \]
The Future?

Thank you for listening