# What's the big deal about ageing aircraft?

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# Defining an ageing aircraft

- No universally agreed definition
  - Pre-World War II?
  - Pre-1950s?
  - Pre-1970s?
  - Chronologically based?
    - Any aircraft >20 years?
    - Any aircraft >30 years?
  - Flight hour based?
    - Any aircraft > 6,000hrs?
    - Any aircraft > 50,000hrs?
  - Combination of the above?

# Limitations for ageing aircraft

- No life-limits in Australia
- A Fokker F.VII/3m could legally be used for Charter Operations in Australia

# The facts of ageing aircraft

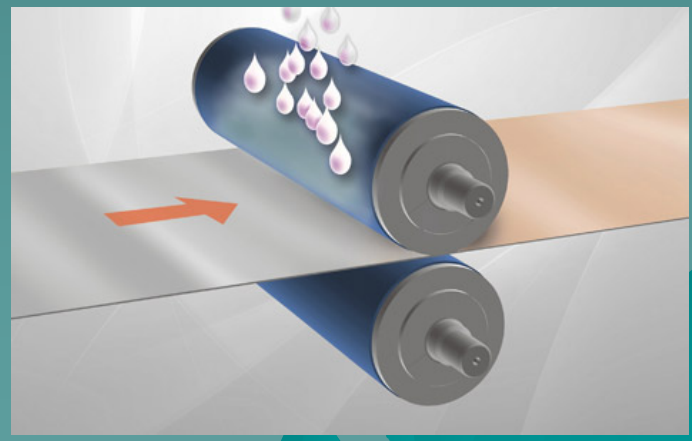
- **All** aircraft are ageing aircraft
- Each aircraft is just at a different stage of its life cycle
- How you design, build and operate an aircraft over its life determines the **rate** at which it ages
- Parallels with humans

# Stages that determine the ageing process

1. Pre-manufacture
2. Manufacture
3. Post-manufacture

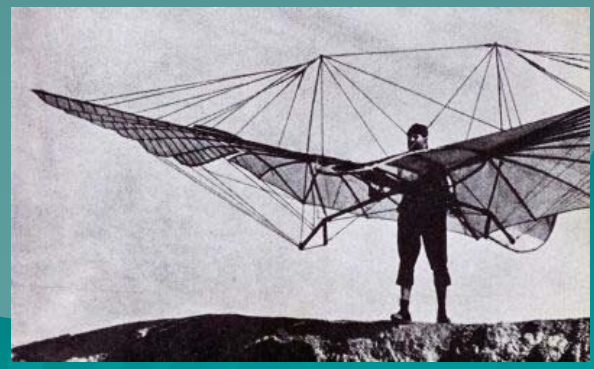
# 1. Pre-manufacture stage

- Certification basis
- Design flaws
- Materials processes
  - Heat treatment
  - Impurities
  - Incorrect storage
  - Incorrect coatings



# Certification basis - fatigue

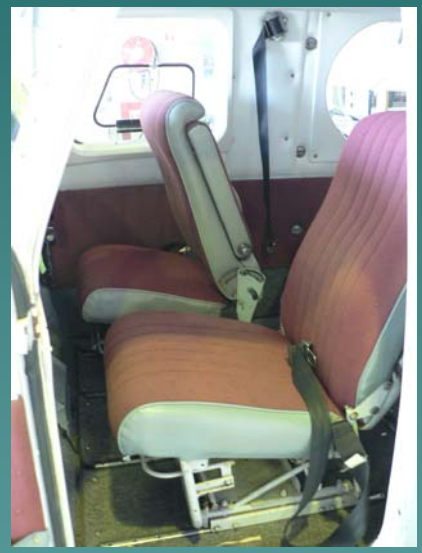
- Prior to 1953 – No specific fatigue requirements for small aircraft
- 1953 – First fatigue requirements for pressurised cabins
- 1969 – Fatigue requirements extended to wings & carry-through structure
- 1989 – Fatigue requirements extended to empennage + introduction of damage tolerance



# Certification basis - crashworthiness

- Evolutionary – capturing lessons learned

1940s



1960s

Now

- An older aircraft is unlikely to be as crashworthy as a later certificated design

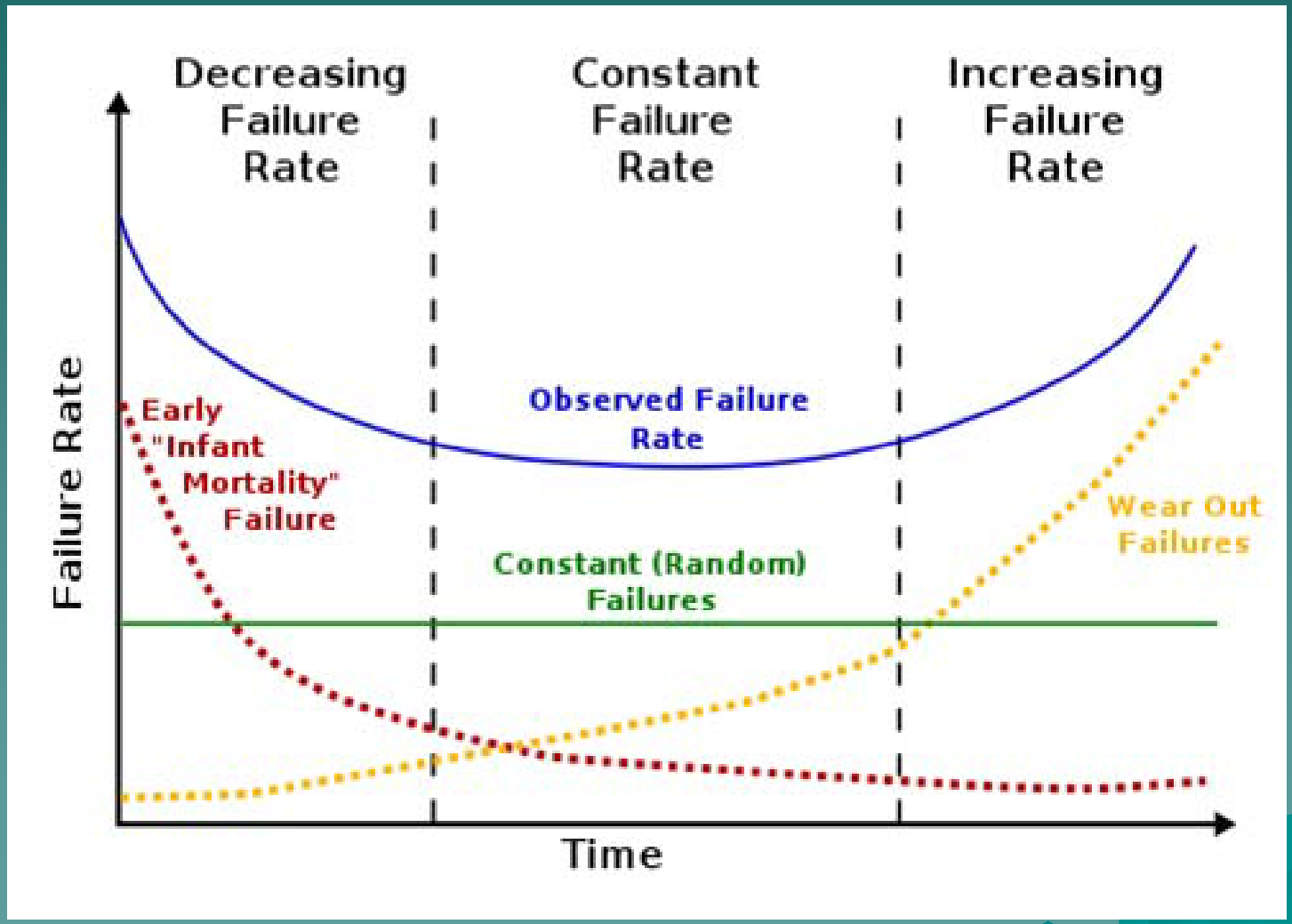
# 2. Manufacture stage

- Flaws Fast-Track Ageing Process (FFTAP)
- Machining errors
- Non-alignment of component parts
  - Percussion installation
  - Making use of the “inherent aeroelasticty of the airframe”
- Incorrect fastener installation
  - Dry-fit
  - Skew-whiff
  - Reworked
  - Wrong part number

# 3. Post-manufacture stage

- Chronological age
- Flight hours
- Cycles (T/O, landings)
- Pressurisation cycles
- Exceedences
  - Reported
  - Unreported
- Standard of maintenance
  - Repairs
  - Modifications
  - OEM support programs (CPCP, SID, etc.)
- Use of unapproved parts
- Type of operations
  - Inside design assumptions
  - Outside design assumptions
- Hangarage
  - Cleaning
  - Protective coatings
  - Exposure to the elements (ocean, sun, rain etc.)

# Bathtub curve



# Maintenance impact

- As any machine ages – it requires more maintenance
- Maintenance costs increase with age
- Additional maintenance activities not necessarily occurring
- “No look” philosophy
  - Minimises “today” costs
  - Increases safety risks
  - Reduces long term positive ageing outcomes

# Key points

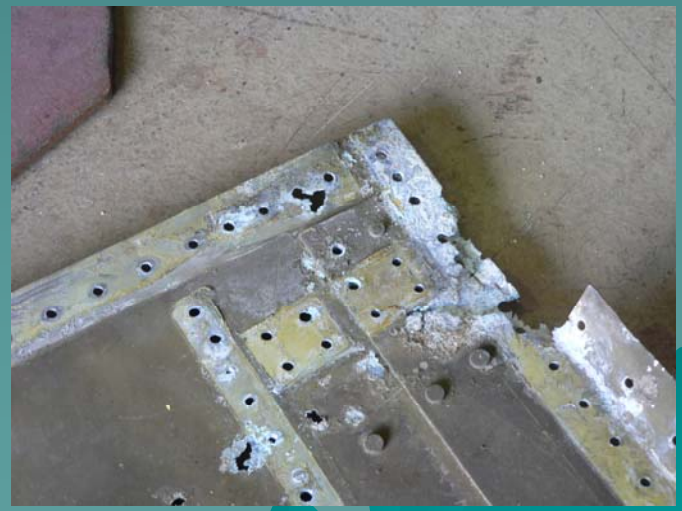
- There is more to “ageing aircraft” than just how **old** the aircraft is
- Each **individual** aircraft ages differently depending on the unique range of variables experienced by that particular aircraft
- There are **good** “ageing aircraft” & there are **bad** “ageing aircraft”

Good

Bad

# Ageing failure modes

- Structural
  - Fatigue
  - Corrosion
- Systems
  - Wiring
  - Circuit Breakers
  - Relays
  - Pneumatic systems
  - Hydraulic systems
  - Cables
  - Seals
- System of Maintenance



# Evidence of internal corrosion

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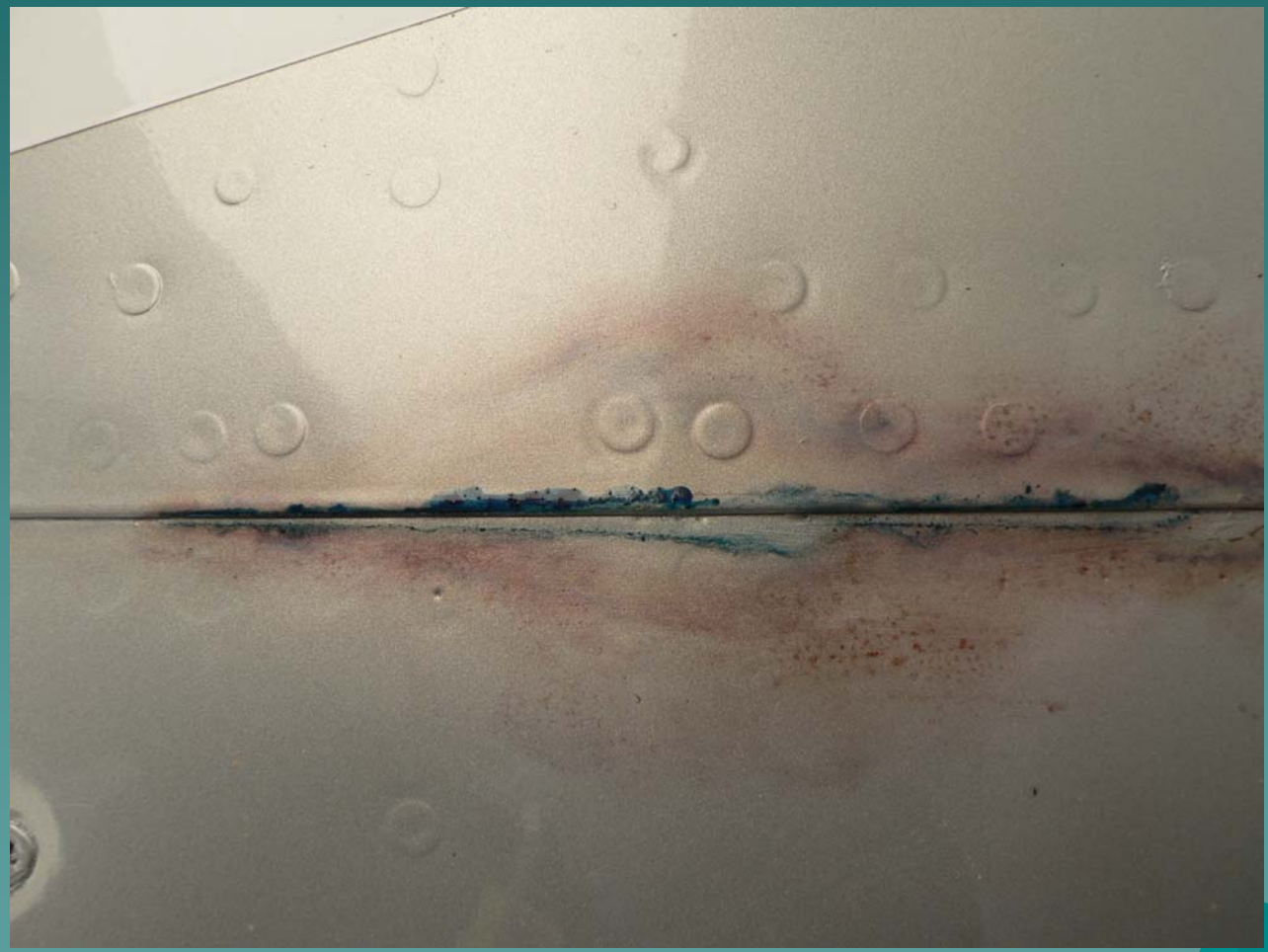
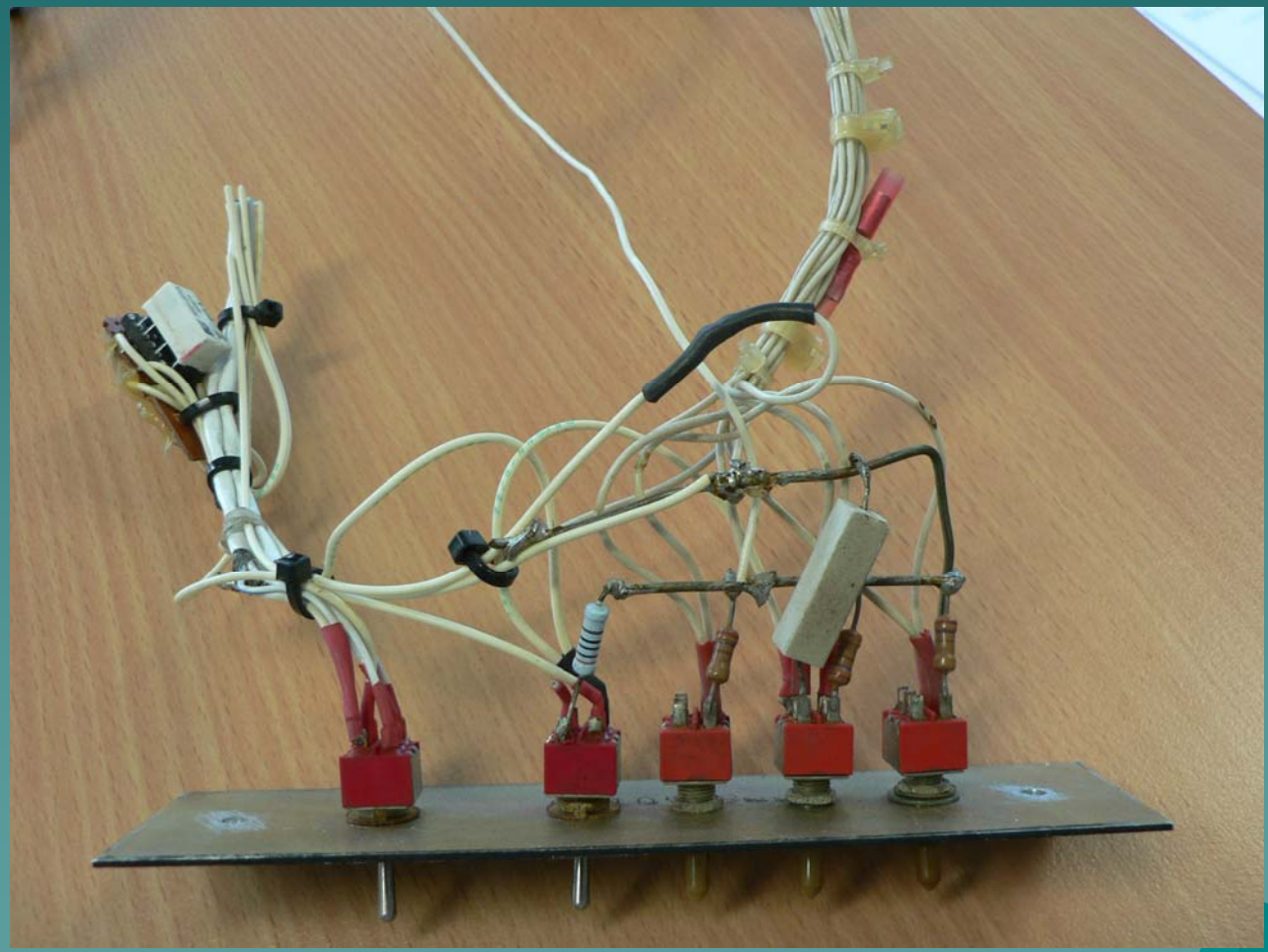


# Ageing wiring



# Ageing battery cable

# Hangarge impact

# Factors exacerbating the ageing process

- Role changes
- New materials
- Configuration management
- Continued operations beyond original design life assumptions
  - Many GA aircraft designed and built in the 1960s–70s–80s had a 20 year design life expectation
  - Many owners have different perspective

# New roles

- Conversions
  - Fire-bombers
  - Freighters
  - Tankers
  - Antarctic ops
- Roles
  - Mustering
  - Aerobatics
  - Gunships
  - Ground based to sea based
  - Carrier based to ground based
  - High altitude to low altitude ops


# New materials - composites

- Expectation that new composite aircraft will remain in service as long as metal aircraft being replaced
- Concerns
  - Interfaces between composites and metals
  - Lightening strikes
  - Ramp damage
  - Effects of secondary loads
  - Consistency of field repairs
  - UV degradation
  - Cumulative effect of all the above over time?

# Configuration Management

- Cumulative effect of repairs & modifications in close proximity over time?

# Summary

- Each individual aircraft ages uniquely
- More maintenance required as aircraft ages – increased costs
- Risks increase with extended life & extended roles if System of Maintenance has **not** been adapted to take these aspects into account

# Questions?