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Bonded Joints in Military Aircraft

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Bonded Joints in Military aircraft

- Successfully used since mid 80's
- Major composite structure for production aircraft
- UK Examples include…..

Harrier Tailplane

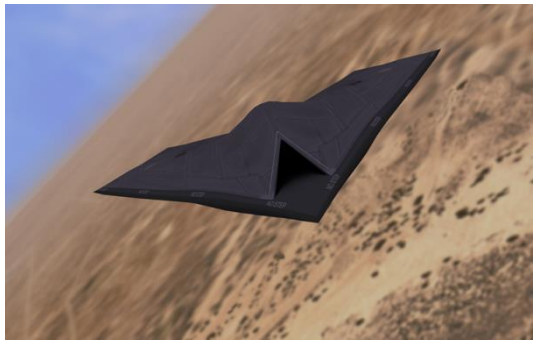
Bonded fuselage structure

Typhoon wing

Typhoon Flaps

Future Military Aircraft - Challenges

- Previous military aircraft projects
  - Design phase several years
  - Typically 1000+ aircraft
  - Large projects, long development, high cost



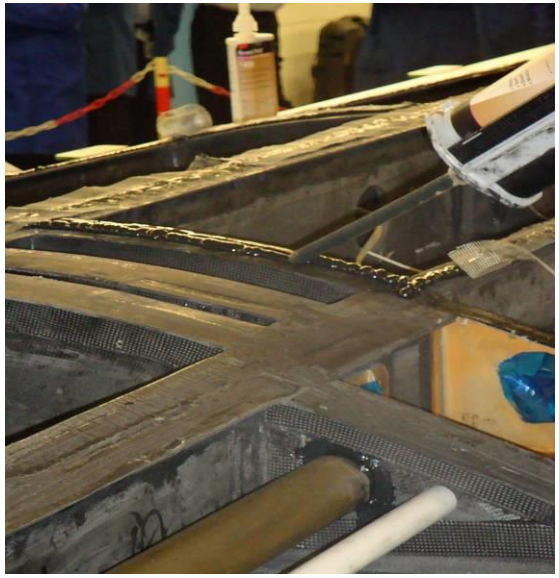
- Future aircraft programmes
  - Small batch numbers
  - Multiple customers / configurations
  - Rapid design process (months not years!)
  - Lower cost manufacturing methods
  - BUT still same level airworthiness

- Option - Bonded structure
  - Problems….

Low Cost Manufacturing Approach

Possible manufacturing solutions include:

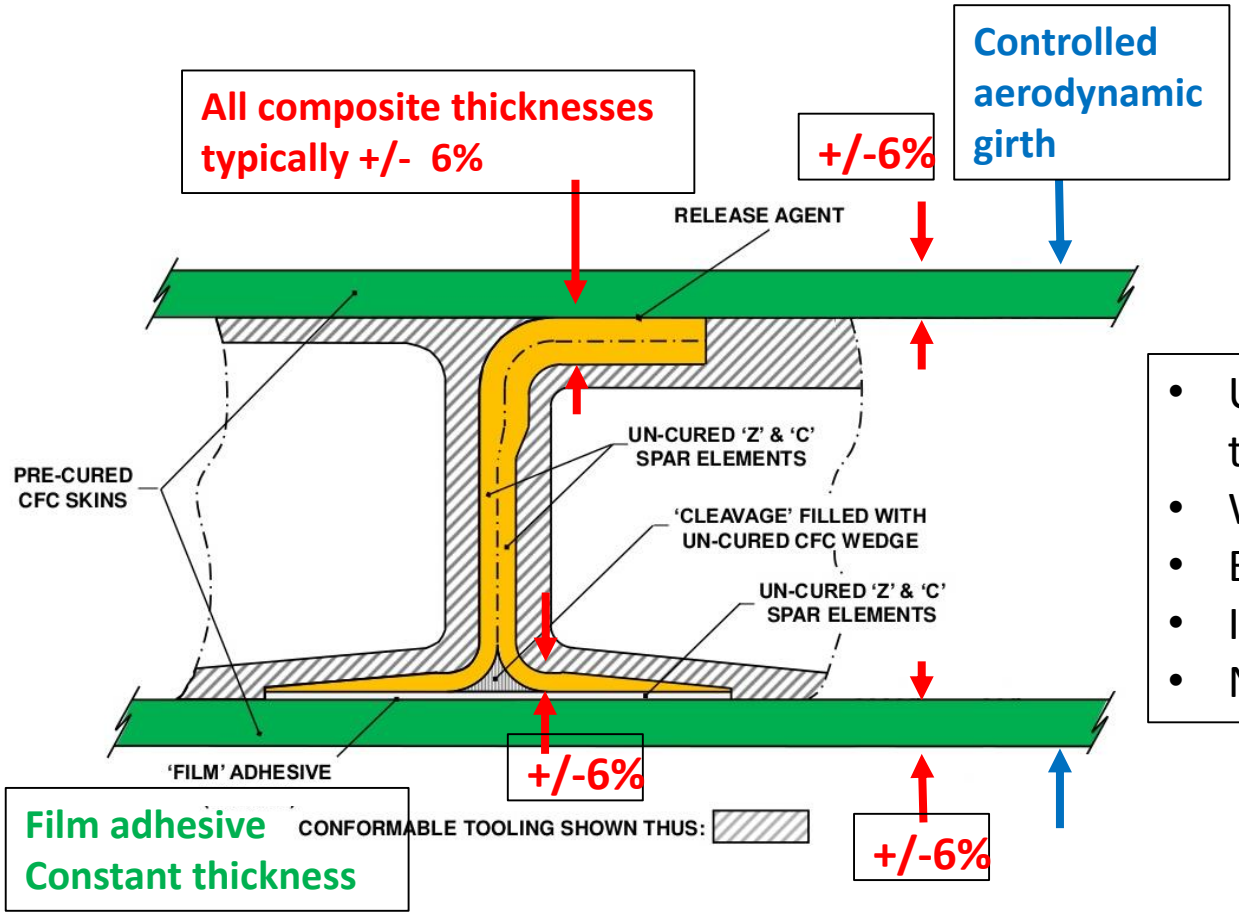
- Out of autoclave processing
- Different material systems
- Low cost tooling



- Bonded rather than bolted structures
- Applications include eg
  - Skin to substructure bonding
  - Spar to rib cleating

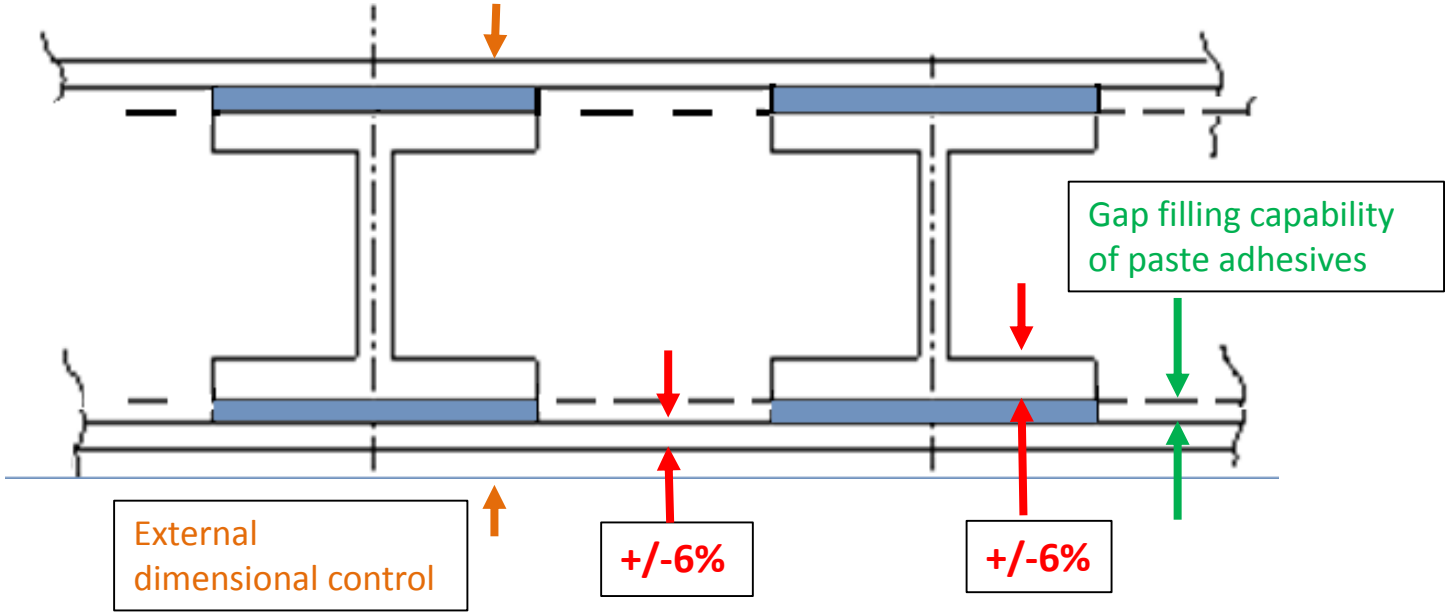
Composite assembly tolerance control issues

- Eg Bonded J spar configuration



- Use precured skins for tolerance control
- Works well
- Expensive tooling
- Inflexible
- Not appropriate small batches

Assembly advantages of paste adhesive

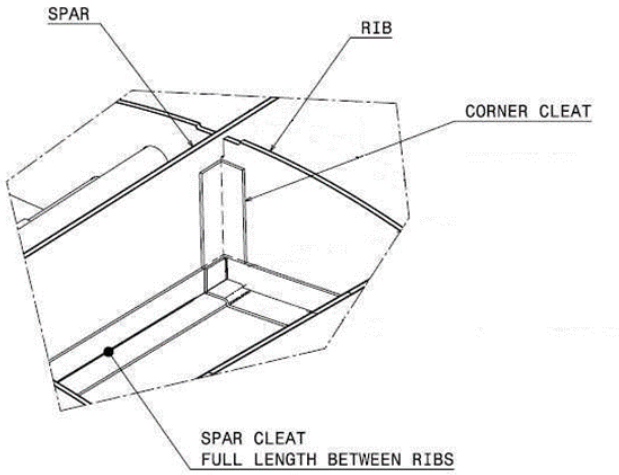


Advantages

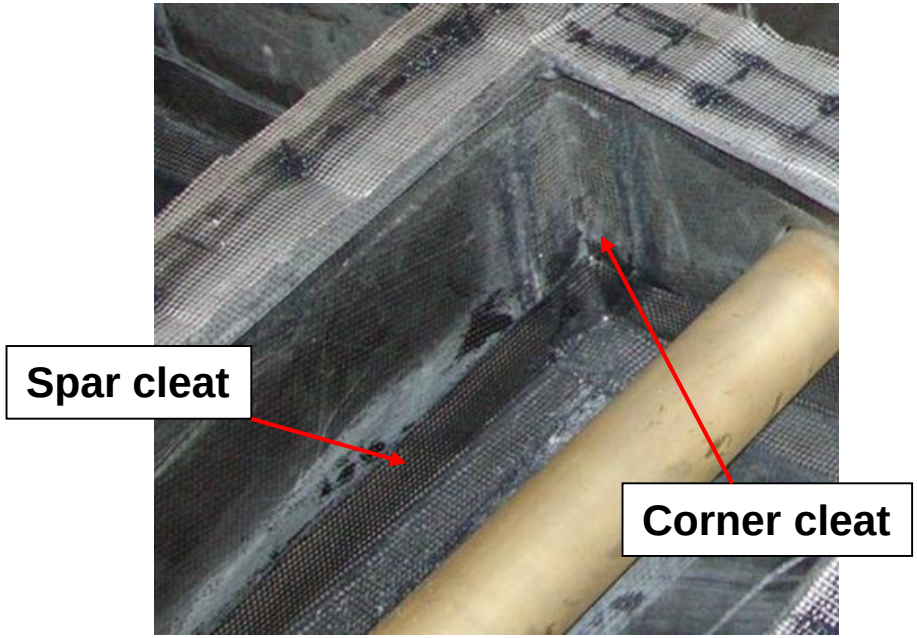
- New paste adhesives – similar strength to film adhesives
- Gap filling capability
- Dimensional control with cheap tooling
- Appropriate small batch manufacture

Problems/ Disadvantages…….

Secondary bonding



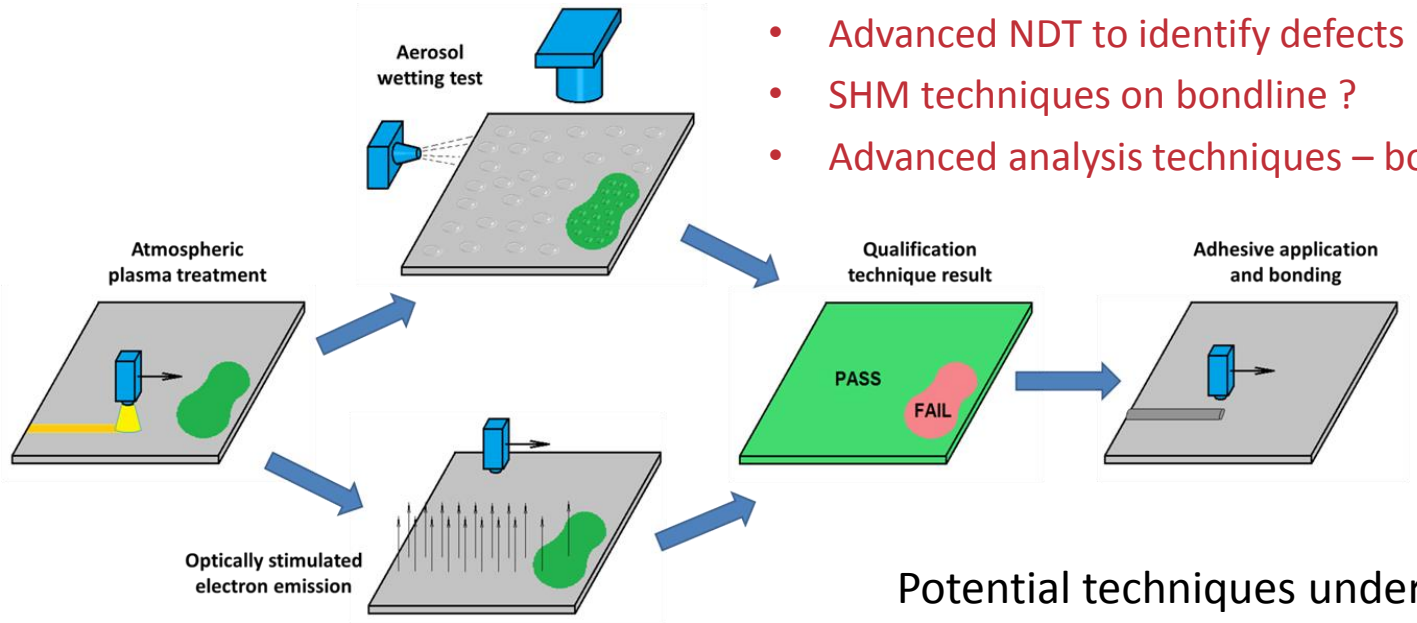
TYPICAL SPAR AND RIB CLEATING CONFIGURATION



- Problems/ Disadvantages…….
  - Pre- cured parts
  - Surface preparation / cleaning
  - Potential contamination
  - Determining / ensuring integrity of bond

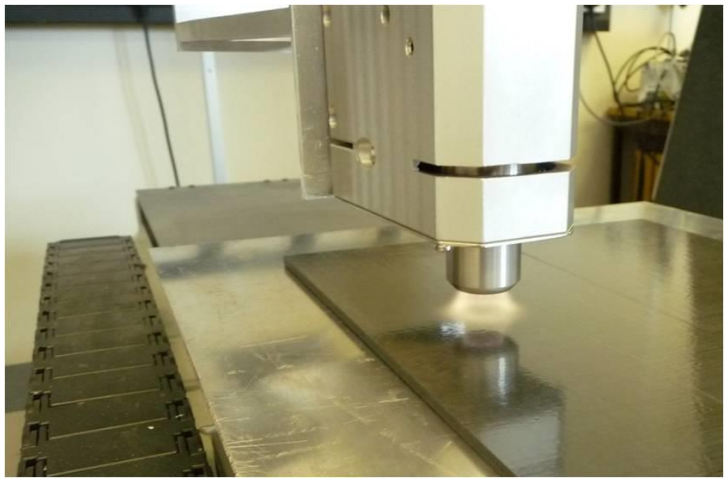
Approach for improvement…..

- Addressing whole process
- Before Bonding
  - Advanced cleaning methods
  - Advanced inspection methods skins after cleaning
- After bonding:
  - Advanced NDT to identify defects ?
  - SHM techniques on bondline ?
  - Advanced analysis techniques – bond strength defect analysis



Potential techniques under consideration

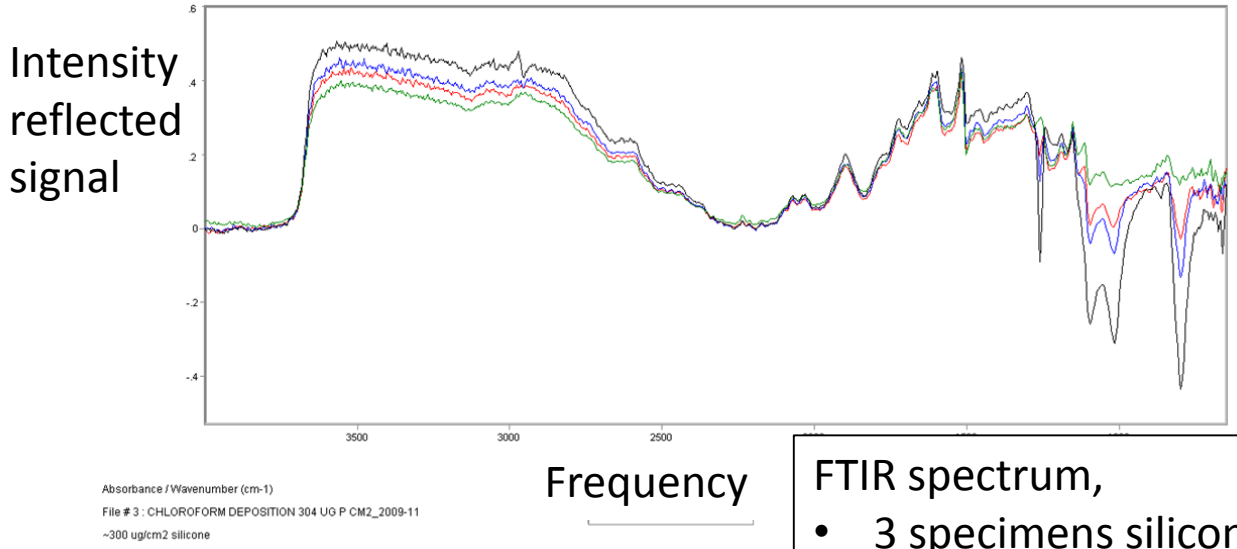
Surface Preparation and Cleaning



- Manual cleaning operation
  - High skill activity ….
  - Could possibly miss the op out altogether…
- Aim – method to take man out of the loop
  - Options include
    - eg plasma cleaning being investigated
    - But sometimes:
      - not remove all contaminants
      - Alter contaminant surface without removing

Surface inspection before bonding

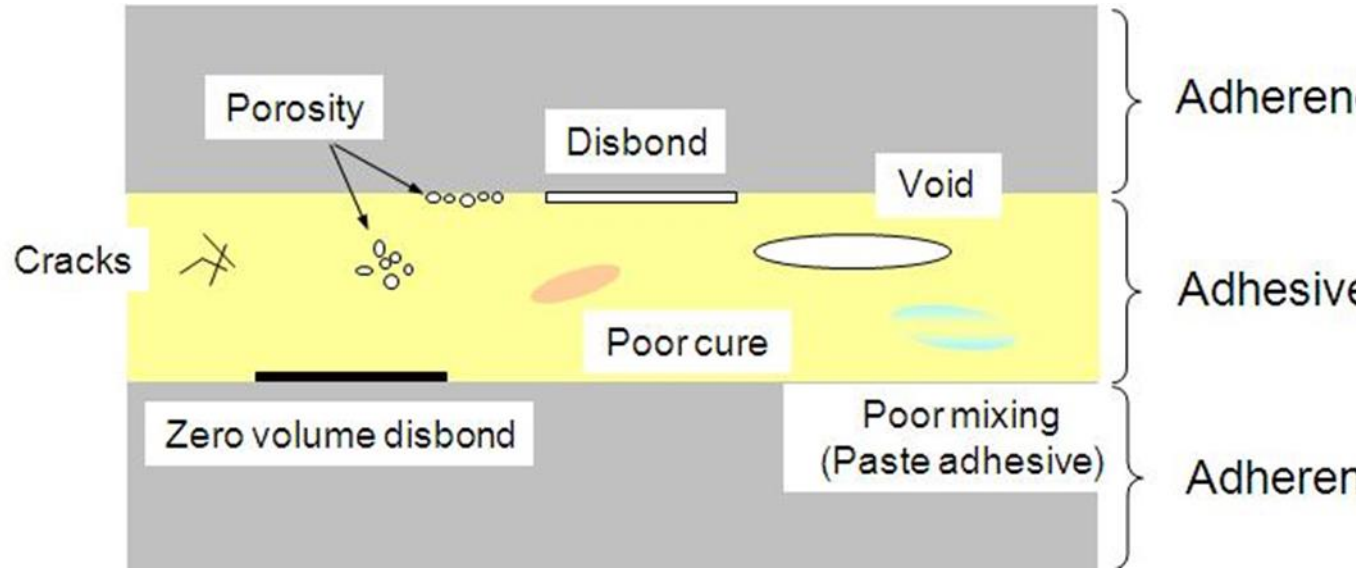
- Traditionally surface wetting
- Aim – Automate , take man out of the process.
- Advanced inspection methods



FTIR spectrum,
- 3 specimens silicone contamination
- one control

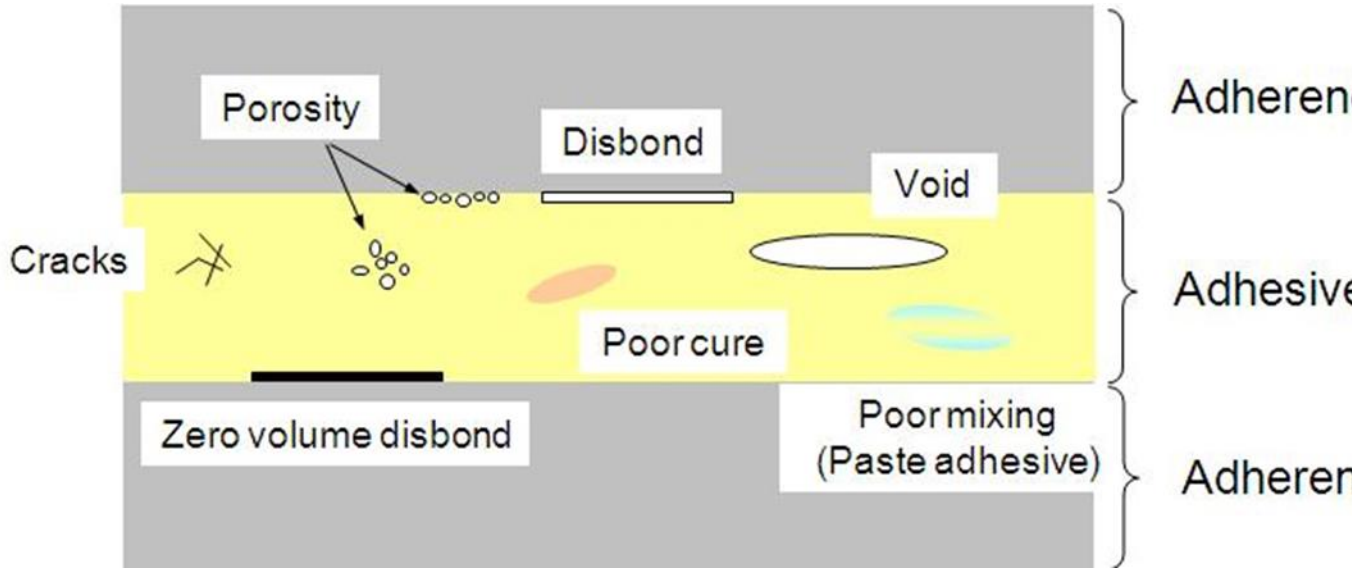
- eg FTIR
  - Issues detecting modified contaminant

Adhesive Bonded Joint Problems



- Bigger issue with paste than film adhesives
- Particularly:
  - More Porosity / voids - limits ability to NDT
  - Surface issues – disbonds / kissing (zero volume bonds) / low strength adhesion
  - Poor mixing
  - Thicker bondlines can lead to more cracking

Adhesive Bonded Joint Problems



- Currently:
  - HAVE to proof load the structure
  - “We must find an NDT technique that gets us away from this position”
  - How does SHM fit in with this?

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Summary

- Future military aircraft
  - Small batch production
  - Short timescales
  - Low cost
  - Same level airworthiness

- New paste adhesives:
  - Low cost manufacturing

- Need to demonstrate bond integrity
  - Currently MUST proof load
  - Need NDT technique to move from this position

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