SANDWICH PANELS IN AEROSPACE

CO-HOSTED BY:

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YOUR HOST

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Associate Technical Fellow
Boeing Canada Winnipeg

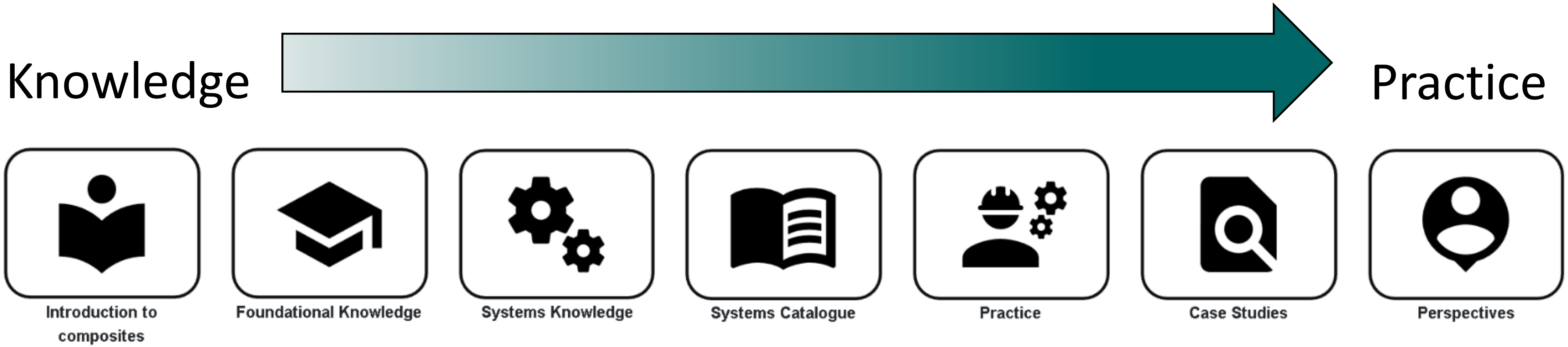
- Master's degree – Composite cure optimization
  - Sponsored by Boeing Winnipeg, Bristol Aerospace (now Magellan in Winnipeg) and the National Research Council
- Experience with electron beam curing, thermoplastic and thermoset composites

KNOWLEDGE IN PRACTICE CENTRE (KPC)

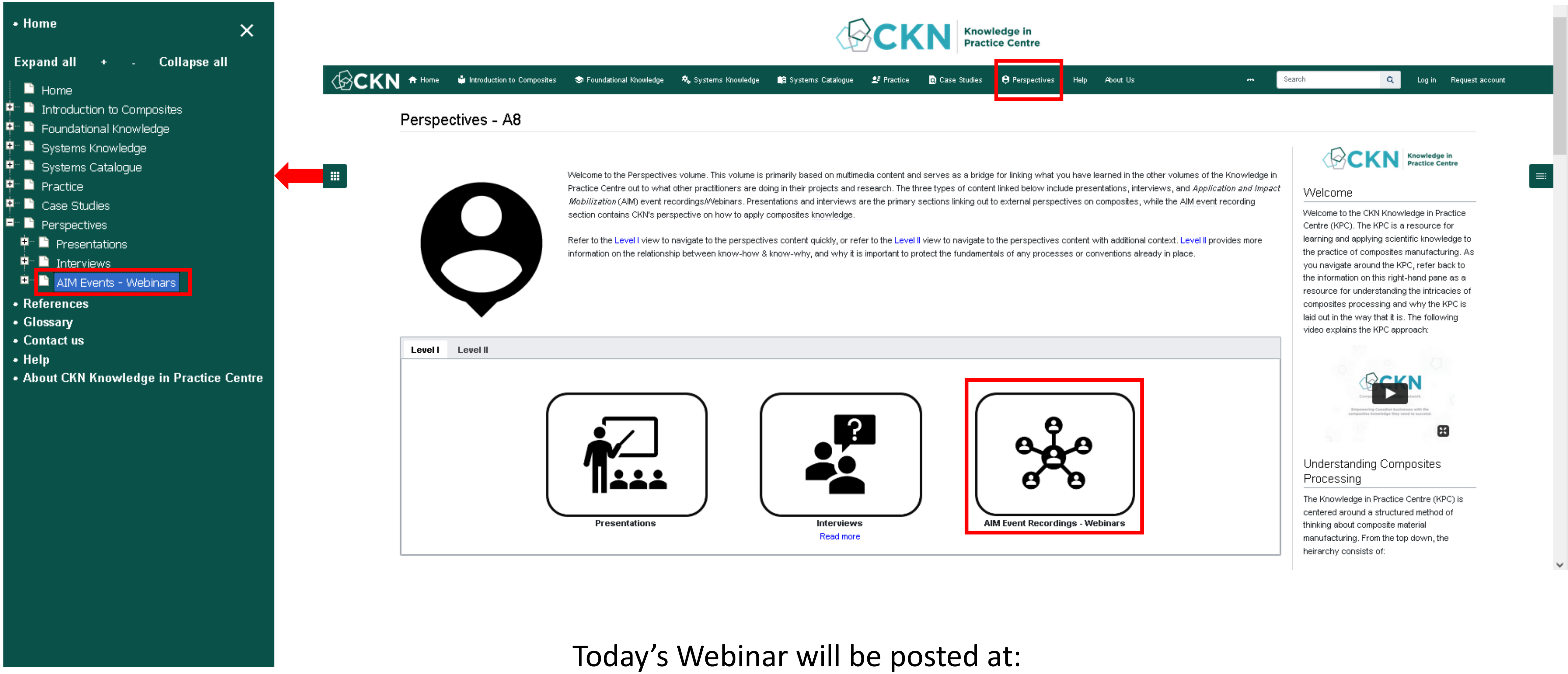
- A freely available online resource for composite materials engineering:

compositeskn.org/KPC

- Focus on practice, guided by foundational knowledge and a systems-based approach to thinking about composites manufacturing



PAST WEBINAR RECORDINGS AVAILABLE



Today's Webinar will be posted at:

https://compositeskn.org/KPC/A341

HOSTED BY: CKN Composites Knowledge Network

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TODAY'S TOPIC:

Sandwich Panels In Aerospace

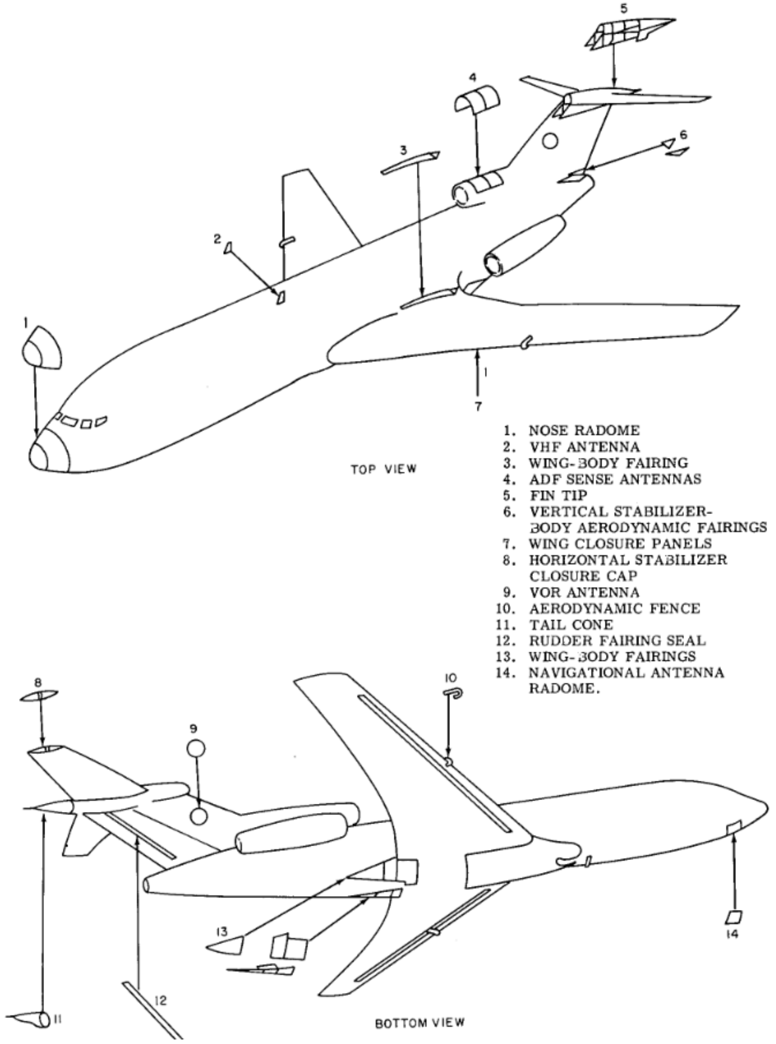
OUTLINE

- History of Composites in Aerospace
- Examples of Sandwich Structures on Aircraft
- Sandwich Panel Construction – Core Manufacturing
- Challenges with Sandwich Panels

HISTORY

- Fibreglass-polyester composites became available during World War II and found immediate application in airborne radomes

- Early Boeing Aircraft:
  - KC-135 - 2-3% surface FRP
  - 707 - 5% surface FRP
  - 720 - 20% surface FRP
  - 727 - 25% surface FRP



Source: Structural Plastics in Aircraft, US DoD, 1965
https://apps.dtic.mil/sti/pdfs/ADA301660.pdf

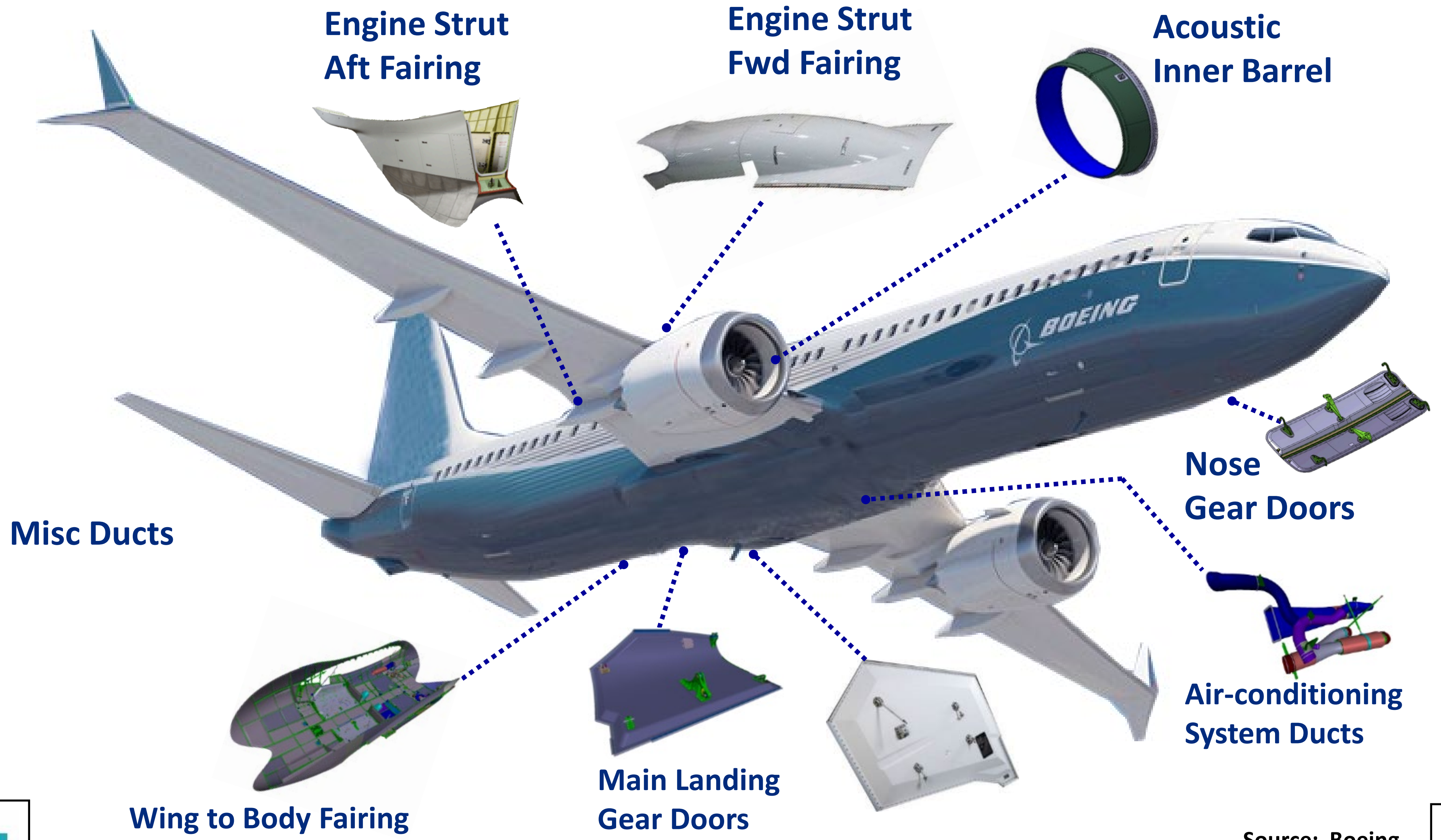
MODERN COMPOSITES

- Now there are nearly all composite aircraft
  - Boeing 787 for commercial airplanes
  - SR series from Cirrus Designs
- Primary structure tends to be laminate with unidirectional prepreg
- Secondary structures and interiors tend to be sandwich panels built with fabric
- Interior and exterior have a lot of common material but interior must meet fire, smoke and toxicity requirements

Cirrus Designs SR22

Source: Wikipedia

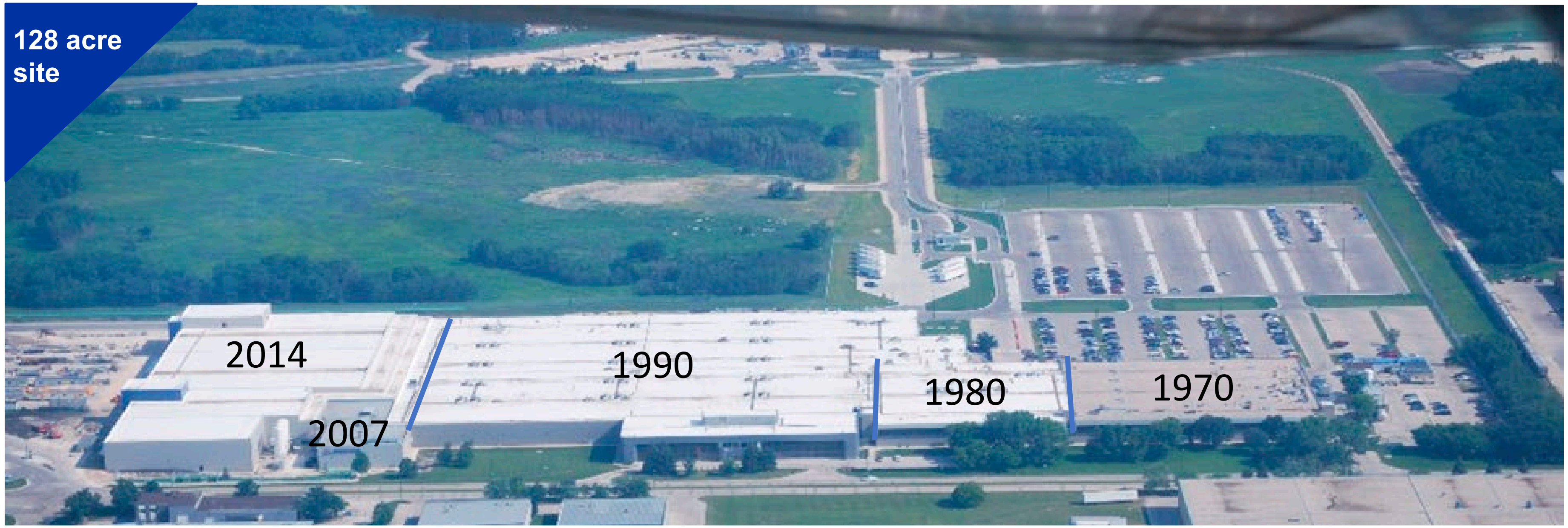
MODERN AIRCRAFT SANDIWCH BUILT IN WINNIPEG



Source: Boeing

HISTORY OF BOEING WINNIPEG

- Established in 1971
- Currently: ~1,350 employees, ~23,000 sandwich panels built this year
- 8 autoclaves



Source: Boeing

COMPOSITE MANUFACTURING PROCESS

1A FIRST STEP CLOTH CUTTING

1B CORE FABRICATION

2 LAYUP

3 AUTOCLAVE CURE

4 MACHINING AND TRIMMING

5 NON-DESTRUCTIVE INSPECTION

6 ASSEMBLY

7 PAINT

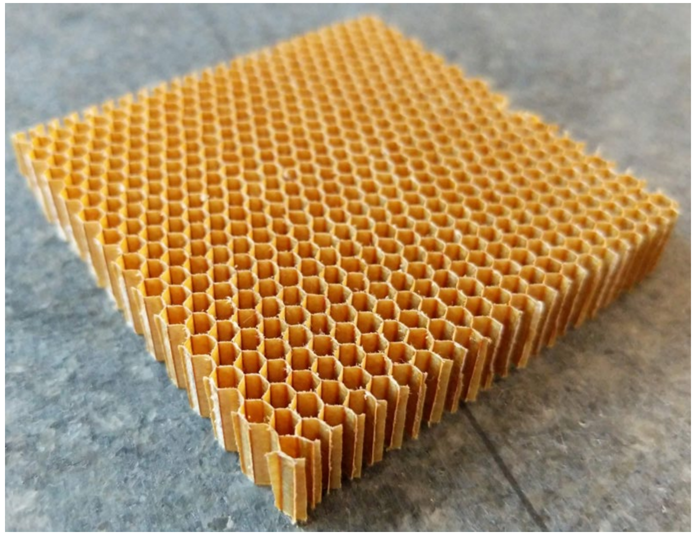
8 FINAL STEP SHIPPING

Source: Boeing

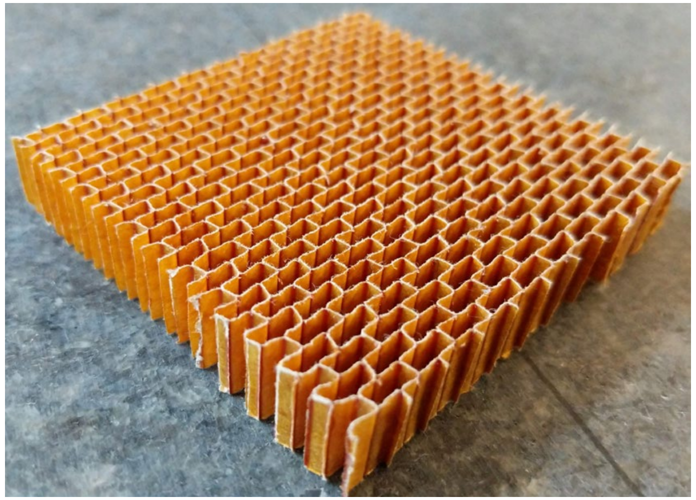
HONEYCOMB CORE

- Fibreglass and Nomex cores from 3 to 16 pound per cubic foot density
- Nomex is an meta aramid fibre most commonly found in fire proof suits
  - Similar to Kevlar which is a para aramid
- Core is dipped in a phenolic resin
- Regular cell, overexpanded (OX) and bisected cell

Regular Hex Cell



Over-expanded Hex Cell



Source: CRN, CKN

CREATE CORE SLICES

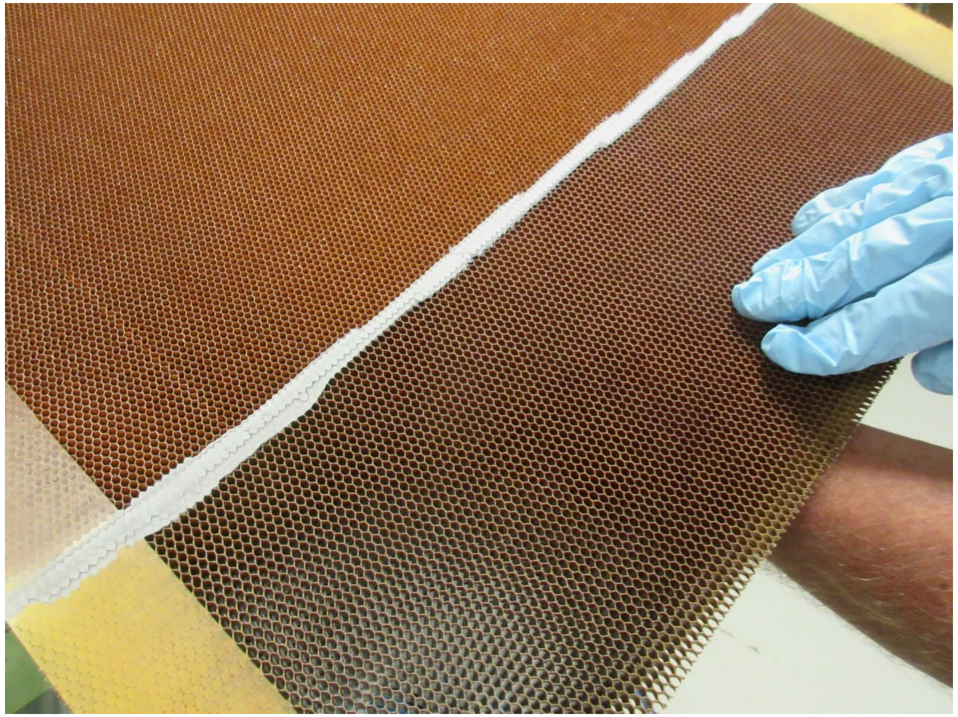
- Core is purchased as blocks and a horizontal saw creates slices of the appropriate thicknesses for panels

Source: Boeing

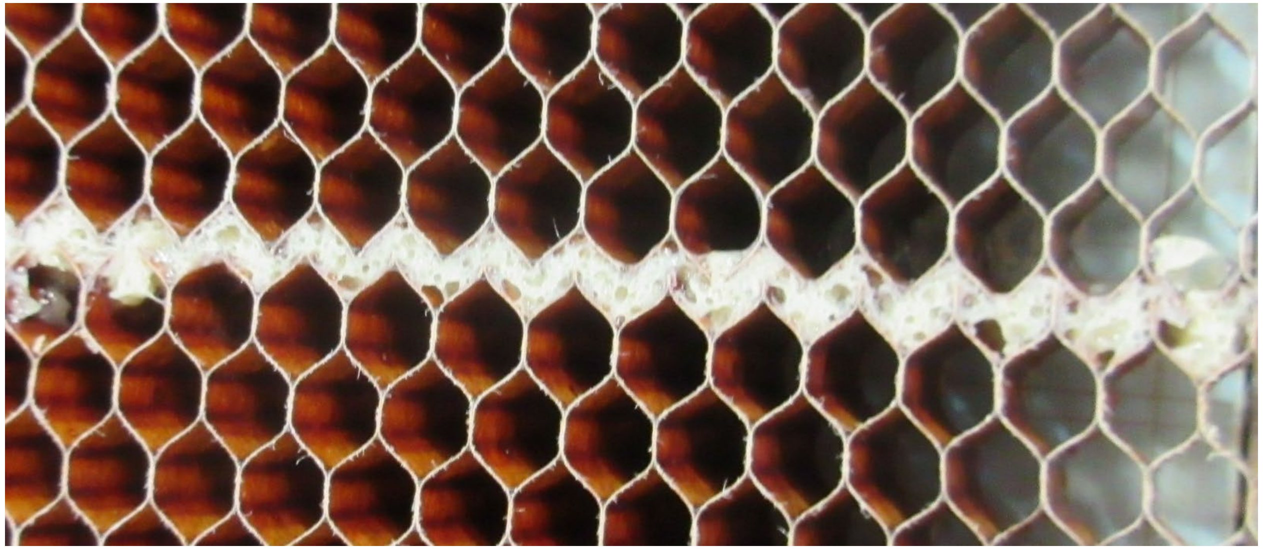
CORE SPLICING – POTTING OR FOAM ADHESIVE

- Foam adhesive is the most common method of splicing
- Potting is used in some circumstances

Potting Splice



Foaming Adhesive Splice



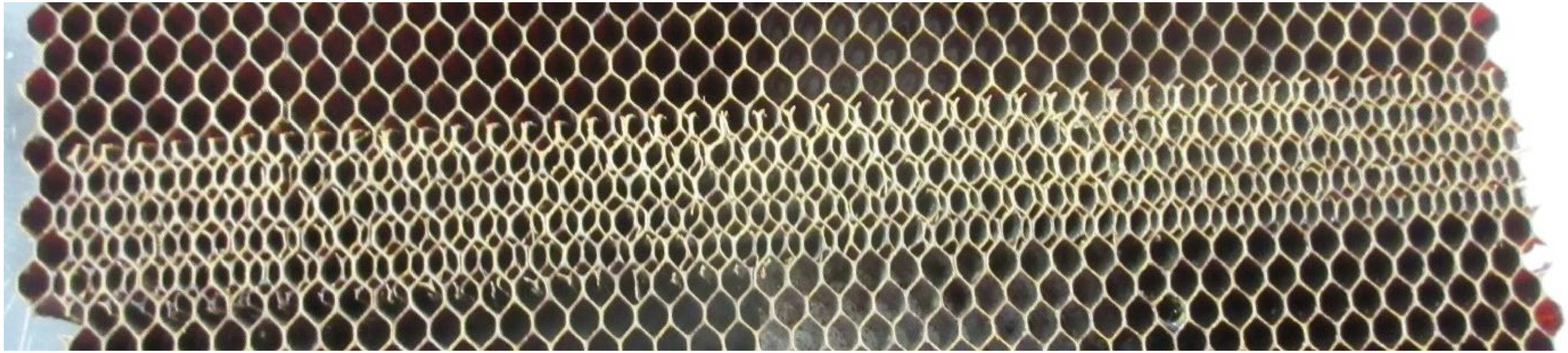
Source: Boeing

CORE SPLICING – Crush / Peg

- Only works on certain densities of glass core

Overlap Crush Splice

Peg Splice



Source: Boeing

CORE SPLICING - SEPTUM

- Sometimes core thickness needs to be reduced to improve forming or strengthen the core laterally to reduce core movement
- Septum is typically adhesive – prepreg - adhesive

Source: Boeing

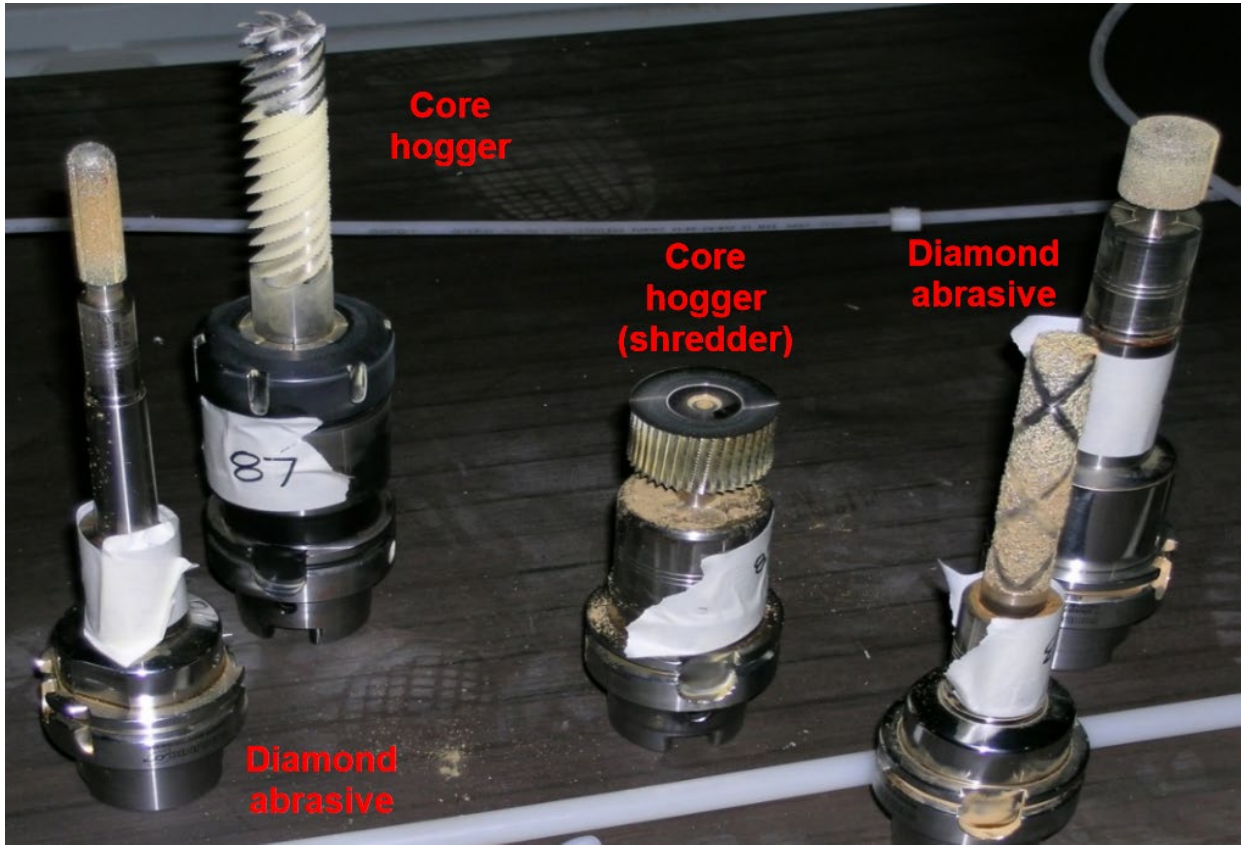
HEAT FORMING

- Over-expanded core can be cold formed into complex contours more readily than hexagonal
- Regular hexagonal can be heat formed into shape

Source: Boeing

CORE SHAPING

- Often use band saw to cut chamfers along edges
- Some cores cut with ultrasonic cutters or milled



Source: Boeing

POTTED LOCATIONS

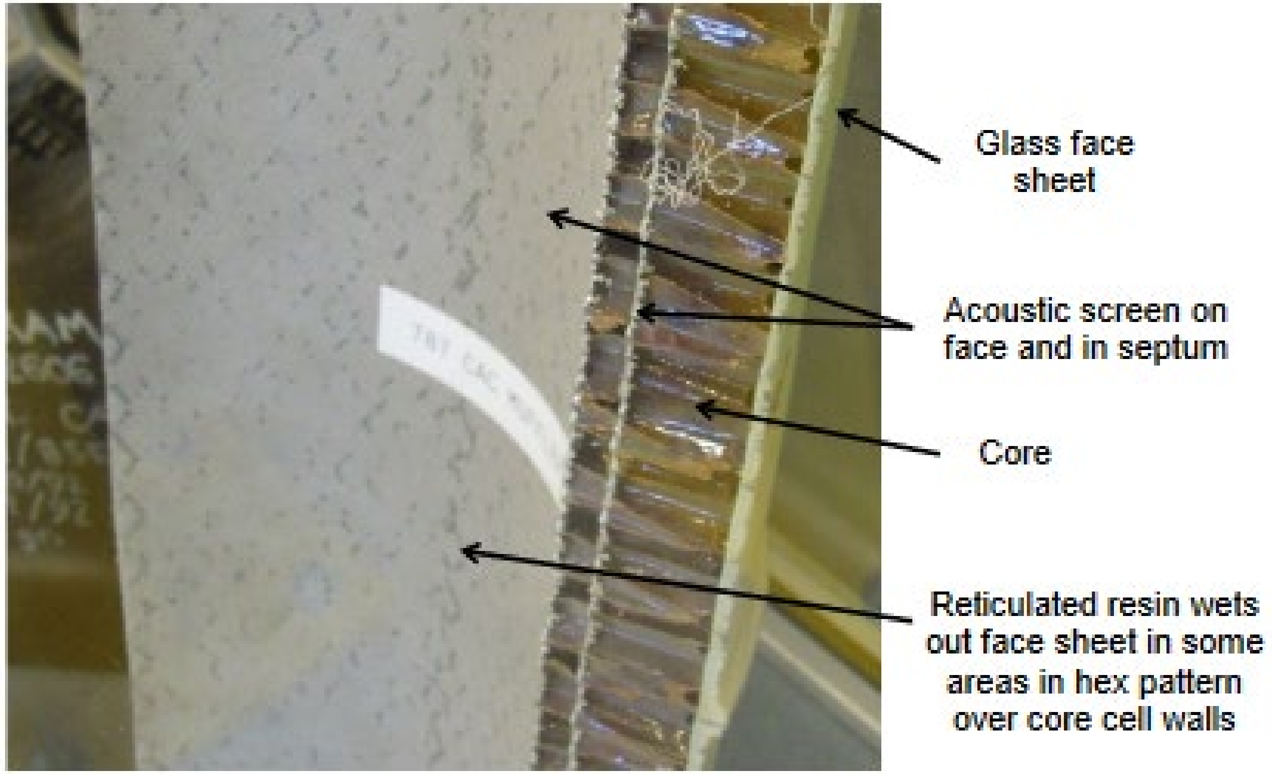
- Core is often potted where attachments are made to the sandwich panel

- Areas are masked off
  - Two part potting can often be poured (centre doughnut shape with potting dam around edge)
  - Single part, frozen potting is often push / pulled in with a vacuum bag (two small circles on masking tape below dammed area

Source: Boeing

RETICULATION

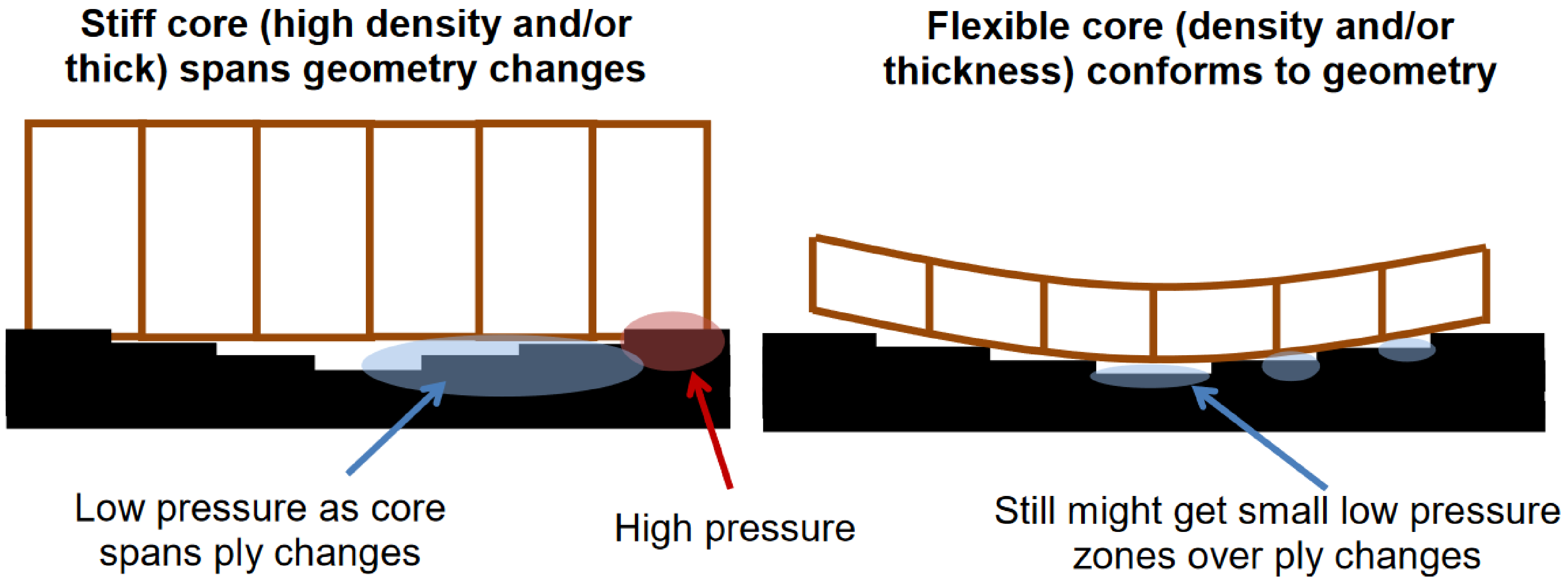
- Unsupported adhesive is reticulated to reduce fouling of acoustic face sheet of acoustic duct



Source: Boeing

CHALLENGES WITH SANDWICH PANELS: CORE CONFORMING TO SKINS

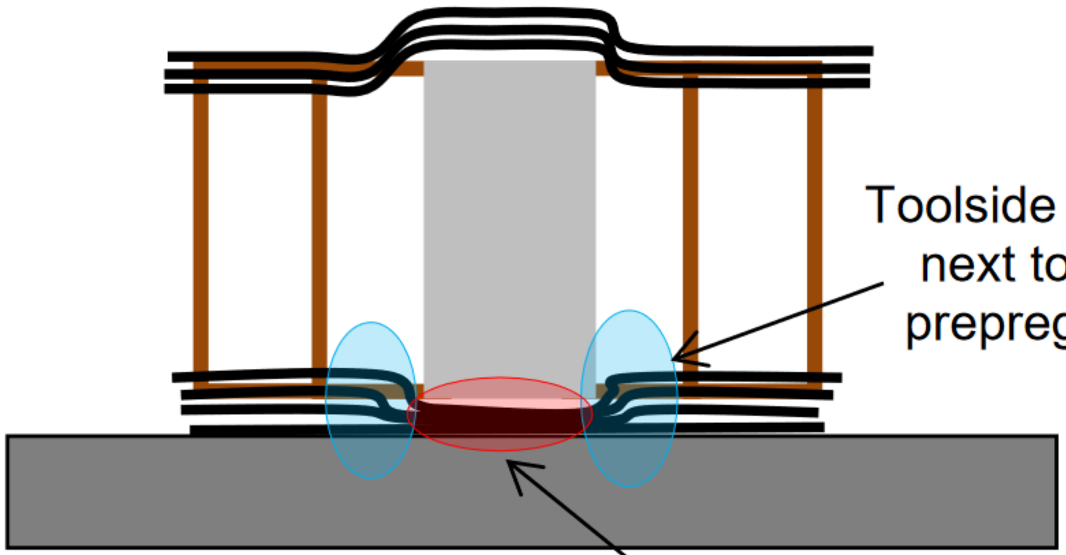
- Pressure to consolidate tool side skins requires core to fit well to transfer pressure



Source: Boeing

CHALLENGES WITH SANDWICH PANELS: PRESSURE IMPACTS OF POTTED LOCATIONS

Bagside – plies do not embed into core at potting location leaving skins proud common to potting area



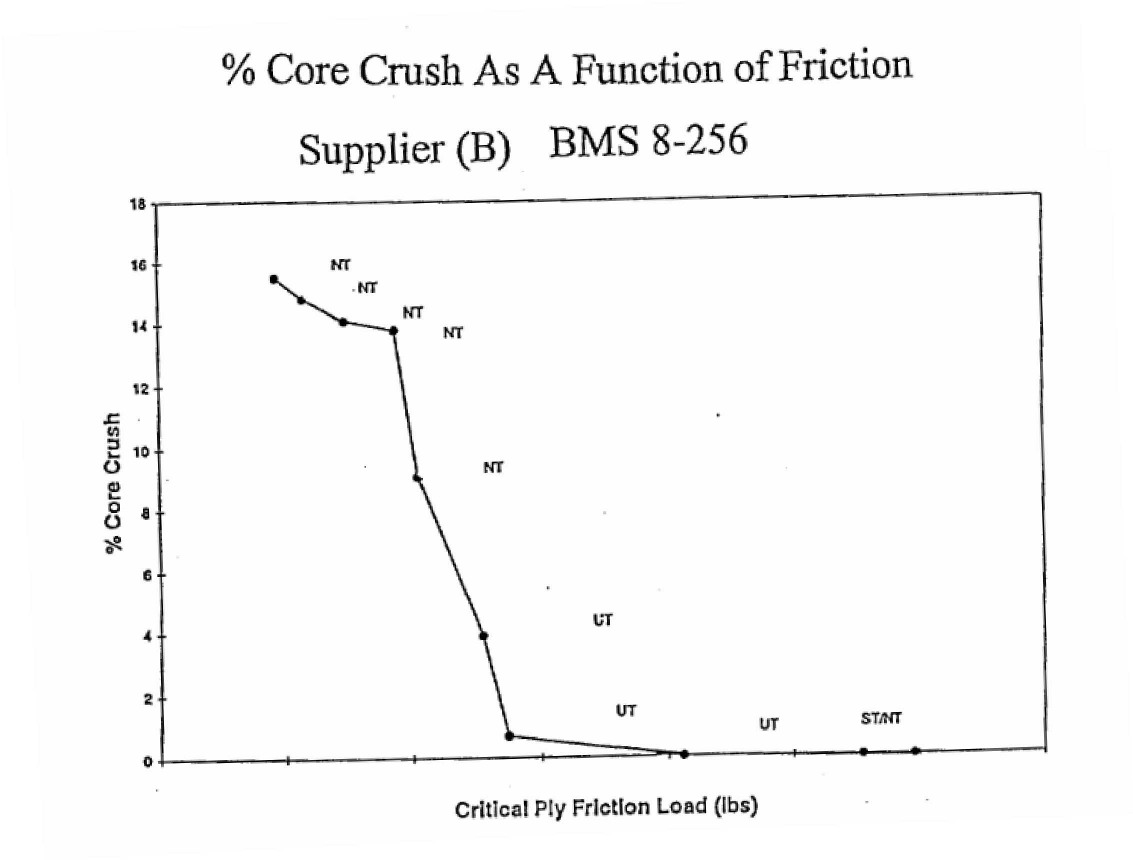
Toolside – low pressure zones next to potting location as prepreg cannot embed into core

Toolside – high pressure zone under potting as prepreg cannot embed into core

Source: Boeing

CHALLENGES WITH SANDWICH PANELS: CORE MOVEMENT

- Standard Twist (ST) prepreg reduces core movement by increasing friction. Never-Twisted (NT) and Untwisted (UT)



Source: T. Schneider, T. Pelton and R. Martin, "Material Factors Influencing Composite Part Producibility in Relation to Prepreg Frictional Measurement," 31st International SAMPE Technical Conference, Oct 26-30, pp. 463-477, 1999.

Thank you for joining us!

Keep an eye out for upcoming AIM events:

Introduction to Adhesive Bonding – Part I
Hosted by Dr. Casey Keulen
January 31, 2024
https://compositeskn.org/KPC/A342

And don't forget to visit the KPC for more information:

https://compositeskn.org/KPC

Today's Webinar will be posted at:
https://compositeskn.org/KPC/A341