A&P Technology

Welcome
• A&P Braiding Capability
• Biaxial / Triaxial Braiding Processes
• Braid Architecture and Construction
• Selected Applications
• Component Testing and Material

Jason Scharf
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A&P Technology History

- Started as R&D division of Atkins & Pearce (est. 1817) 1986
- Incorporated in 1995; independent in 1997
- Moved to 80,000 sq.ft. facility in 2000
- Added 35,000 sq. ft. facility in 2002
A&P Technology Braiders

- World leading capacity to design novel braided architectures
- Design and build all textile machinery in-house
- Own and operate the most technically advanced line of braiding machines anywhere
Aerospace Structures
Other Products
Classic Braid Constructions

- Sleevings
- Tapes
- Slit tapes
- Flat broadgoods
- Cored braids
- Ropes
- Uni-braids
- Uni-broadgood
Shaped Braid Preforms

- Overbraids
- Curved Sleeves
- Curved Tapes
- Helical Braids
- Variable
- Jelly Roll Braids
- Filler Noodles
Raw Material Choices

- Fiberglass*
- Carbon
- Aramid
- Polyester
- Vectran
- Spectra®

- Nylon
- Metalized Polyester (Mylar®)
- Ceramic
- Twaron
- Nicalon®

*Also Available as Texturized Fiber
Braided Architectures

Sleeve

Tape

Width or perimeter is sum of yarn widths
Biaxial

- Flexible diameter, good conformability & drape
- Fibers in the bias direction only
- Construction dependent fiber orientation ranging from 15 to 75 degrees
Biaxial Braid
# Biaxial Braid Design Options

## Variations in Braid Layer Thickness

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<th>Standard sleeve</th>
<th>Constant thickness</th>
<th>Constant angle</th>
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Triaxial

- Locked diameter or width
- Fibers in both axial and bias directions
- Fiber orientation ranging from 10 to 80 degrees
Unidirectional Products

Unimax™ - conformable sleeving available in carbon and fiberglass; small elastic bias yarns enable even distribution of axial yarns.

MegaBraidertm

800 Carrier  336 Carrier
600 Carrier  272 Carrier
500 Carrier  208 Carrier
400 Carrier  172 Carrier

A&P Technology has the largest braiding machinery in the world.
Why Megabraiders?

- Larger diameter braids/wider bias fabrics
- Smaller unit cell braids (higher picks per inch)
- Smaller yarns resulting in less crimp.
NASA Airlock

800 carrier
Vectran
84” diameter
10’ long
Applications

Engine Containment  Ducting/Tubing
Propeller Blades  Fuselage Frames
Missile Nose  Control Surfaces
  Cone/Bodies  Exhaust Nozzles
Engine Stator Vanes  Straight and Curved
  T- and I-Stringers
Aircraft Ducting

RTM with internal bladder and integral flange using biaxial sleeving
Braided Airfoils
Control Surfaces

- SLATS
- FLAP
- Vertical Stabilizer
- Horizontal Stabilizer
- Rudder
- Trim Tabs
- Elevator
Braid use in Fuselage Frames

• Braid axis follows skin
• C & L shaped, variable flange angle, variable gage and variable curvature
Curved C-Channel Preform using Triaxial Sleevering
Braided and Stitched T-Section Preform
Braided Cases/Ducts

Williams International Jet Engine Fan Case

GE F110 Exhaust Shroud
Multiple Mandrels
Mantis Has Hoop Winding Capability

Localized IM7 for hat stiffener

T700 Wide Tow
GE F110 Exhaust Shroud Overbraid Process

4 preforms packaged on one overbraid mandrel

Hat Stiffener

4 Pack for Process Demonstration Minus Outer Layers
Capstan Winding - Jelly Roll Braids
GE CF6-80C2 Braided Kevlar Containment

Dry, triaxial braided tape wrapped circumferentially to achieve cost, weight reduction
GE Fan Case (2005)

- High strength containment necessary to stop failed blade from penetrating fuselage
- Superior damage tolerance
- Composite fan case reduces engine weight by 350 pounds, or 700 pounds in a two engine aircraft
Component Testing

- Engine Containment
- Panel Impact Failures
- Pressure Vessels
- Stator Vane Hail
  Impact
Flat Panel Impact Test Fixture

24" panel

20" or 22" opening

0° (axial)

-60° (bias)

+60° (bias)
Impact Video of Aluminum Panel
0.071" Aluminum Panels after Impact

V = 513 ft/s (156 m/s)  
(Test LG393)

V = 743 ft/s (226 m/s)  
(Test LG468)
Impact Video of (0+/−60) Composite Panel
(Velocity below penetration threshold)

V = 491 ft/s (150 m/s)
(Test LG380, 7,100 pps)
(0+/-60) Composite Panel after Impact
(Velocity below penetration threshold)

Front

Back

Close-up view at center of panel

V = 150 m/s (491 ft/s)
(Test LG380)

Fiber and matrix failure in back ply
Impact Video of (0+/-60) Composite Panel
(Velocity above penetration threshold)

V = 743 ft/s (227 m/s)
(Test LG375, 7,100 pps)
(0+/-60) Composite Panel after Impact
(Velocity above penetration threshold)

Front

Back

V = 743 ft/s (227 m/s)
Test LG376
Pressure Vessel Testing

Over-wrapped, Aluminum Lined Pressure Vessels
Vessels are pressurized with liquid nitrogen (-320F) and shot with a 50 caliber bullet. The 800 grain bullet at 2600 ft/sec has approximately 15,242 joules of energy.
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Filament Wound Vs. Braid

Filament Wound

Braid
Stator Vanes
FAA Required Simulated Hailstone Impact Tests

Airfoil Design with Tape

Ice Ball Weight: 65.7 g
Velocity: 293.6 fps
FAA Required Simulated Hailstone Impact Tests
Airfoil Design With Braid

Ice Ball Weight: 63.0 g
Velocity: 296.9 fps