Next-Generation Composites in Aircraft Engines: Approach to Development and Production Implementation

ABC 2013 Annual Conference
September 24, 2013
Albany International

NYSE: AIN
$761M 2012 revenue
$1.05B enterprise value

2 businesses
19 plants
11 countries
4,000 employees
Albany International
-- Two Businesses

Advanced textiles
Materials processing
Process automation
Cash flow
AEC is Leveraging 50 years of Corp. Experience in Engineered Textiles and Process Automation

- Process automation
- Automated error detection
- Fiber handling technologies

Automated seaming machine for paper machine clothing
- 576 warp ends
- Visioning system
- Multiple machine operation

3D weaving loom for advanced composite fiber preforms
- 8448 warp ends
- Multiple fill selectors
- Integrated process data collection

new directions in composites
AIN Locations

Worldwide Presence
• 19 plants in 11 countries
• 4,000 employees
AEC Operations

- $75M revenue
- $12M R&D
- 535 employees

LEAP Plant 1
Rochester, NH USA
353,000 ft²

LEAP Plant 2
Commercy, France
235,000 ft²

Rochester, NH USA Building 2
130,000 ft²

Rochester, NH USA Building 1
150,000 ft²

Boerne
135,000 ft²
Simplified Description of Current SOA: Conventional Laminated Composites

- Sheets of fiber pre-impregnated with resin ("prepreg") cut on machine into "plies"
- Plies are individually layered onto a tool ("lay-up")
- "Lay-up" is vacuum-bagged to tool and put into autoclave to cure
Next Generation Composites Technology:
3D Woven Composites

- Thousands of individually controlled fibers,
- woven in three dimensions into a near net shape “preform,”
- which is trimmed and formed,
- and into which resin is injected and then cured in a net-shaped tool.
3D Woven Composites

- The weight-savings of conventional composites

  *Plus*

- Greater impact resistance
- More complex shapes
- No delamination
- Use of high-temp fibers

A game changer in composites . . .
opening up entirely new opportunities for weight savings on the engine . . .
Next-Generation Composite Technology
3D-Woven/Resin Transfer Molded (3D/RTM) Composites

3D Weaving Process

RTM Process

new directions in composites
ALBANY Engineered Composites
Near Net Shape Preforms Reinforce 3D Composites In The LEAP Engine

- Improve damage tolerance
- Reduced touch labor
- Improved performance
Representative Fiber Architectures – 3D

μCT scan

Interlocking ‘layers’ to prevent delamination
Primary Benefits

- Improved damage tolerance and improved resistance to out-of-plane loads leading to reduced weight

- Reduced cost due to reduced touch labor

Figure 1 - 4 point bending test result

Figure 7: Bird strike test setup for woven composite fan blades
Our Partner

Relationship established in 2000
LEAP®: The First Engine Application For The Next-Generation Composites Technology

CFM International, a 50/50 joint venture between Snecma (SAFRAN) and GE

Snecma work share includes the fan module and low pressure turbine

LEAP® (future generation)

CFM56® (current generation)

new directions in composites
3D/RTM Composites in LEAP Fan Module

Fan Case

Platform (18 total)

Fan Blade (18 total)
Platforms on Which LEAP® Engine to be Used

- 100% market share
- est. ~50% market share
- 100% market share
Progress Along The Technology Readiness Level Maturation in Partnership with Customer

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• Similar Manufacturing Readiness Level (MRL) exists
• Specific criteria exist for each readiness level
• Self-assessment (today):
  - TRL 7
  - MRL 5 ➞ 7 (depending on specific process)
Partnership (1)

- **TRL 1-3:**
  - Vision/patience/commitment to disruptive technology during R&T phase is critical
  - Concurrent engineering between partners key to success

- **TRL 3-4:**
  - Initiated early commercialization discussions during transition from TRL 3 to TRL 4
  - Enhancements to manufacturing technology to suit product requirements
  - Design rules to accommodate manufacturing technology
Partnership (2)

• **TRL 5-9:**
  - Imbedded expats as program launch neared
  - Industrialization agreement established: extended the ‘technical partnership’ to a ‘full partnership’ by addressing commercialization prior to program launch
  - After program launch, established work share and co-located production development work center within AEC’s Rochester, NH operations
  - Partnering discussions established with local City and State governments during broader site selection activities
    - Land, access, and improvements from City of Rochester
    - Employee training funds, R&D tax credits from State of NH
The Production Challenge
Co-Located Plant Manufacturing Operations

Dedicated plants in Rochester, NH and Commercy, FR
Further Strengthening of Partnership

- Per 8K filing, in late March 2013, Albany International Corp and Safran S.A. signed letter of intent for Safran to purchase an equity position in a new Albany subsidiary to be known as Albany Safran Composites, LLC

- ASC will be the exclusive supplier of advanced 3D-woven composite parts for Safran for use in aircraft engine and other ‘Safran Applications’
To Be Continued …..
Future Applications Under Development

• Organic Matrix Composites
  ➢ Fan Case Module

• Ceramic Matrix Composites
  ➢ Low Pressure Turbine

• Other Engine Platforms - TBD