Overview of Composite Material Trends in Aviation Manufacturing

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The aviation industry is a major contributor to the economic vitality of Kansas and has the potential for significant growth as a national center for aerospace innovation.
Kansas Products
Aviation Economic Impact in Kansas

- **36,500 direct jobs with a payroll of approx. $2.4 billion**
- **Each aviation job generates an additional 2.9 jobs**
- **Kansas delivers more than 50% of all U.S. general aviation aircraft** (1,263 aircraft valued at $3.7 Billion in 2002)

- **2016 State tax revenues forecast:**
  - 16% of total state payroll
  - $1.3B in state tax revenue
- **Wages expected to skyrocket in 10 years – $5.5 Billion/Year**
Composite Material Definition

- Macroscopic combination of two or more distinct materials having a recognizable interface between them
Fiber Reinforced Composite Types (polymer matrix based)

Aerospace Composites
A Long History in Military & Space Applications
Existing State-of-the-Art in Composite Aircraft Structures

**Transport Aircraft**
- Secondary structure
- Control Surfaces
- Empennage
- Wing & fuselage applications for new aircraft
- Some engine (e.g., fan blades)

**Small Airplanes and Rotorcraft**
- Most structures
  - Pressurized fuselage
  - Wing
- Dynamic components
  - Propellers & rotor blades
- Extensive bonding
Barriers to Expanded Application

Transport Aircraft
- Manufacturing cost
- Non-recurring development costs
- Maintenance technology
- Limited resources with sufficient training (engineers & technicians)
- Lack of standardization

Small Airplanes and Rotorcraft
- Manufacturing cost
- Need to reach high production rates
- Maintenance technology
- Limited resources with sufficient training (engineers & technicians)
- Lack of stable material supplier base
- Lack of standardization
Boeing 787 Composite Usage

Nearly all of the exterior surfaces are composites, except the leading edges of the wings, the stabilizers, and the engine pylons.
Boeing's Plastic Dream Machine

Excerpts from BusinessWeek, JUNE 20, 2005 and Boeing News Releases

• Boeing thinks its new 787 jet, built mostly of plastic composites, could remold the airline industry.

• Jets made of composites require far fewer parts, so there's less to bolt together.

• …since these plastics weigh less than aluminum, the planes should burn less fuel. … together with improved engines, 20% drop in fuel costs.

• …improve passenger comfort. The superior strength of the composite fuselage will allow the passenger cabin to withstand higher pressurization -- equal to the air pressure at an altitude of 6,000 feet instead of the usual 8,000 feet.

• …it's easier to control cabin temperature, humidity, and ventilation.

• …engineers are discovering that their composites are even tougher than they initially imagined.... maintenance costs will be 30% lower than for aluminum planes. …corrosion and fatigue benefits are going to be astounding.
Raytheon’s Premier I – All Composite Fuselage
Cirrus Design Corporation, Duluth, MN
The Institute’s Composite Family
Informational Brief

AeroStrategy is a consulting firm devoted to aviation and aerospace sectors with offices in Ann Arbor and Amersham, U.K.

A white paper highlighting trends in the aerospace supply chain can be downloaded at http://www.aerostrategy.com/commentary.cgi

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Aerospace Comprises Approximately 15% Of The $50B Global Composites Industry

- The global composites industry, “notoriously difficult” to estimate, is worth $50B in 2004 according to JEC composites
- The automotive industry is the largest segment and is worth in excess of $12B
- Building and construction is a fast-growing segment and is now worth $10B annually
- Aerospace is the third largest segment…and a major consumer of carbon fiber given its focus on performance
- Wind power is emerging as a significant market and is now worth nearly $1B

Sources: JEC composites, European composite directory and report 2002 – 2003; aerospace figures from AeroStrategy
Aerospace excludes launch vehicles and satellites
Values are for end-use products
The Aerospace Composites Market Is Worth $7.3B In 2006

2006 Aerospace Composites Market
Total = $7.3 B

- Demand for aerospace composites (finished products only) is $7.3B in 2006
- Air transport production is the largest market segment for composites at $3.3B
- Maintenance, repair and overhaul (MRO) services for composites accounts for nearly one-quarter of market value

Source: AeroStrategy
Notes: excludes UAVs, figures in 2006 dollars
The Use Of Composites In Modern Aircraft Designs Is Accelerating…

Aircraft Composite Content For Select Airframes
% of structural weight

- Military aircraft designs were early adopters of composites
  - Performance oriented
  - Less cost sensitive
  - Unique requirements (e.g. radar signature suppression)

- The latest commercial designs, led by the B787, A380, and A350 XWB, feature significantly greater composite content

- Airbus recently announced that it has added a hybrid composite/metal fuselage to the A350XWB design

Sources: Teal Group, Boeing, Airbus, Composite Market Reports
...And Will Underpin A Quadrupling Of The Aerospace Composites Market Over The Next 20 Years

Aerospace Composite Market Forecast ($B)
2006 - 2026

Source: AeroStrategy
Notes: excludes UAVs, figures in 2006 dollars
Why The Shift?

Fuel & Emission Reduction

Push To Reduce Maintenance Cost

Falling Production Cost

Emergence Of Sophisticated Supply-Base (E.g. Spirit, GKN)

Improved Knowledge Base (I.e. Better Design)
Composites Raw Material Suppliers Have Consolidated In Recent Years

Commercial Aircraft OEM – Composite Supplier Relationships

1980’s

Boeing, DASA, Douglas, BAe, McDonnell, Airbus, General Dynamics, Martin Marietta, Lockheed

1980’s Suppliers:
- Boeing
- BAe
- McDonnell
- Airbus
- General Dynamics
- Martin Marietta
- Lockheed
- Boeing
- BAe
- McDonnell
- Airbus
- General Dynamics
- Martin Marietta
- Lockheed

Today

Boeing, Airbus

Today Suppliers:
- Boeing
- Airbus
- Boeing
- Airbus
- Boeing
- Airbus
- Boeing
- Airbus
- Boeing
- Airbus

Materials (Prepreg)

Culver City, Cytec, American Cyanamid, ICI Fiberite, BASF, Hercules, DuPont, BP, Hexcel

Fiber

Hercules, BASF, Amaco, Toho, Toray, Akzo

Source: Cytec
Note: Tier I and Tier II suppliers not depicted
Aircraft And Engine OEMs Are Increasingly Focused On System Integration

Aircraft Production Supply Chain

- More focused on systems integration
- Less internal production capability
- Desire to work with a smaller number of Tier 1 primes
- Significantly reduce direct dealings with Tier 2 and Tier 3 suppliers

Source: AeroStrategy analysis
Tier 1 Suppliers Have Significant Growth Opportunities

Aircraft Production Supply Chain

- Taking on more integration and supply chain management activities formerly performed by OEMs
- Leveraging aircraft OEM aerostructures outsourcing – “available” market growing faster than overall market growth
- Entering more risk sharing partnerships
- Facing consolidation (e.g. Spirit – BAE Aerostructures, GKN – Teleflex Aerospace Manufacturing Group)
- Struggling with surging demand, rising raw material costs, and shifting material content

Source: AeroStrategy analysis
Tier 2 And 3 Suppliers Face Significant Challenges

Aircraft Production Supply Chain

- Shifting distribution channels: less direct dealings with OEMs; more with Tier 1 suppliers
- Vigorous competition from low labor cost suppliers
- Struggling with surging demand and rising raw material costs
- May face consolidated demand as Tier 1s consolidate
- In the long run, must address shifting material content

Source: AeroStrategy analysis
Wichita Is One Of Several Aerospace Composite Clusters

North America
- Wichita – Tulsa
- Salt Lake City
- South Carolina

Europe
- Spain
- Italy
- U.K.

Asia Pacific
- Japan

MITSUBISHI HEAVY INDUSTRIES, LTD.
Kawasaki
FUJI HEAVY INDUSTRIES Ltd.
‘TORAY’
Toho Tenax
The Shift To Composites Highlights Several Key Issues For Wichita

Porter’s Sources of Locational Competitive Advantage

- To what extent will other aircraft OEMs – including business aviation – follow Boeing’s lead?
- What are the implications of the shift to composites for suppliers focused on metallic work?
- Are there enabling technologies or processes that can improve the competitiveness of metal structure suppliers?
- How significant is the opportunity in composite MRO services?
- What is required to strengthen the competitiveness of Wichita’s aerostructures/composites cluster?

Source: Michael Porter, AeroStrategy analysis
SUMMARY - Why Composites?

- Superior performance when compared to steel or aluminum (in many applications)
- Reduces weight
- Reduces maintenance costs
- Reduces or eliminates corrosion
- Better fatigue resistance
- Less thermal expansion
- Enhanced properties via tailorable properties
  - Mechanical
  - Electrical
  - Anisotropic vs. isotropic
- Reduces cost (?)

COMPOSITES ENABLE THE ENGINEER TO CUSTOMIZE STRUCTURE