Trends in the Aerostructures Composite Supply Chain

SpeedNews Aerospace Raw Materials & Manufacturers Supply Chain Conference

March 2011

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Part Of A $4.8 Billion Corporation
Three Major Manufacturing Facilities
Over 50 Years Of Experience
  • Automation
  • Large Primary Structure

Markets:
  • Space And Launch Vehicle Structures
  • Military Aircraft Structures
  • Commercial Aircraft Structures

Growth Programs:
  • F-35 Primary Structures – Wings, Engine Inlet Ducts and Engine Nacelles
  • A350 Stringers and Frames
  • GEnx Fan Containment Case
  • Rolls Royce Trent XWB Rear Fan Case
  • Demonstration Contracts
Agenda

Background

Trends
  ➢ Market
  ➢ Technology

Summary

B748-8 with ATK Engine Fan Containment Case on Board
Background
Background: Composites

Combination of Fiber (Strength/Stiffness) and Resin (Form and Load Transfer)

Advantages:
- “Additive Process”
- Light Weight
- Near Net Mold
- Unitized Construction (Reduced Part Count)
- Fatigue Resistant
- No Corrosion Issues

Differences
- Non Conductive
- Quality Is Process Dependent
- Design
- Damage Tolerance / Detection

Delta Launch Payload Fairing – ATK Iuka, Mississippi
Background: Traditional Manufacturing Flow

Material Mfg: “Prepreg” Resin/Fiber Combination

Hand Lay Up

Tape Laying

Fiber Placement

Lay Up Or Lamination: Hand Or Automated Processes

Cure: Temperature and Pressure

Machine NDI Assembly
A Capital Intensive Business

- Clean room: $100+ / sf to modify
- Automated Tape Layer / Fiber Placement Machine: $3 - 15M
- Autoclave: $1 - 10M
- Non Destructive Testing: $1 - 7M
- Machining Center: $2 - 15M
The Trend Driving the Trends
The Opportunity: We Have Been Waiting For This…

“Fly away” Composite Structures in Mlb.

Assumes no Airbus / Boeing NSA until after 2020
Assumes B777X in 2018
MFW: F-16, F-18, F-22, F-35, Rafael. Eurofighter, C-17 & A40M
Future Trends

Industry Impact
Technology
Aerostructures Industry in Transition

B767 / A330

• Aircraft Structure 5 - 15% Composite
• Majority of Suppliers Focused on Metal Based Processes
• Composites Expertise Limited
  • Automation Domain of the OEM
  • Labor Intensive Composite Manufacturing at Small and Foreign Companies

B787 / A350

• Aircraft Structure 55% Composite
• Composites Expertise Expanding
  • Automation Domain spread to Large Partner / Tier 1’s, Some Tier 2’s
  • New Composite Manufacturing Processes at Tier 2 and Tier 3’s
• Supplier Base Split Between Metal and Composite Based Processes

People – Different skills
Capital Investment – Different Equipment / Facilities
Process Development – Different Processes

Carpe Diem: Spirit’s Investment in B787 $500M+
Trend 1: Who Can Afford the Transition?

1. Large companies can afford it
2. Mid size companies will struggle
3. Many small will not transition
Trend 2: Divergence of Market Needs

1980’s
- Military applications tech development
- Shared similar rate production needs
- US / EU lead structures industry

1990 – 2000’s
- Commercial benefitted from development
- Beginning of off shoring
- Large scale commercial use begins
  - 5X military use in lbs

2010’s
- Commercial will be 20x military use in lbs
- Traditional suppliers
- New suppliers in Asia, Middle East
- Divergence in requirements – Commercial vs Military
  - Long vs short production runs
  - Efficient integrated structure vs “Multifunctional” structure
  - Open supply base vs closed supply base

What will be the impact on the industrial landscape?
Trend 3: Automation...Continues

Evolution of Composites Processing

Composite content


- Wet Hand layup
- Hand layup
- Resin Infusion
- Other
- Auto Tape Lay
- Auto Fiber Placement

Composite Content
Trend 4: Reduced Assembly & Part Count

“Black Aluminum”
- Composite components
- Assembled together

Co-cured / Assy of Sub-Components
- Composite skin/stringer sub section
- Assembled together
- Example B777 tail, A330 tail, A380 CWB
- B787 fuselage barrel (skin/stringer)

Co-cured Sections
- Stitched / infused technology as an example
  - Composite Skin / stringer / frame or spar
Reduce Manufacturing Costs

Stitched Integrated Structure / Resin Infused Structures

- NASA/Boeing (PRSEUS)
  - R&D Wing (MD-80) 1992 – 2000
  - Fuselage – On going
- Bombardier
  - CSeries Wing
Trend 5: Reduce Processing Costs / Capital Cost

Out of Autoclave Processing

Eliminate:
- Capital expense (multi $M)
- Bottle neck (flow time)
- Recurring expense (energy and nitrogen)

Process:
- Oven / vacuum bag cure
- Self heating tools / vacuum bag cure

Application:
- Over sized structures
- Multiple small parts

Boeing 2010 SAMPE Display
Trend 6: Far Out Future Trend?

Additive Manufacturing – The Next Disruptive Technology?

- **Additive manufacturing (AM)** is defined by ASTM as the "process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to ‘subtractive manufacturing’ (machining) methodologies”

- **Metal or plastics deposited 20 um at a time, layer by layer**

Photographs via Morris Technologies
Summary of Trends

1) Trend toward increased use of composites – growth is in the commercial market
2) Capital intensive business
3) Market consolidation / restructuring – “creative destruction”
4) Market requirements divergence – what is the impact?
5) Automation will continue
6) Design and manufacture to reduce part count
7) Reduce dependence on large capital equipment
8) Potential “disruptive” technologies on the horizon
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Evolution of the Industry

### Early 1980’s
- **OEM’s (Many)**
- **Tier 1’s**
- **Tier 2 (Few)**
- **Materials Suppliers (Many: 8 - 10)**

- **Design**
- **OEM Controls Processes**

- **Result:**
  - High costs
  - Limited commercial use

### 1990’s
- **OEM (Consolidation)**
- **Design Responsibility**
  - **Tier 1’s**
  - **Tier 2 Build To Print (BTP)**
  - **Low Cost Zone (10 - 20)**
- **Materials Suppliers (Consolidation)**
- **OEM Controls Specs**

- **Result:**
  - Tier 1 & 2 loose design skills
  - Automation domain of OEM and Tier 1’s
  - Death of innovation at the Tier 2 level

### 2000’s
- **OEM**
- **Partner**
- **Tier 1**
- **Tier 2 (20+)**
- **Materials Suppliers (3+)**

- **Result:**
  - Move to global partner model
  - Industry transitions to new technology

- **New Technology - Military driven**
- **US / EU focused supply base**
- **Innovation from Small Companies**
- **Design via supply base**

- **OEM’s “Composites are strategic”**
- **OEM’s take control of technology**
- **Offsets help sell aircraft to Asia**

- **Result:**
  - High costs
  - Limited commercial use