
Edward G. Carson
CEO, GMC2 LLC
**Personal Background**

**Education**
- M.A. Economics, Western Washington University
- B.A. Economics, University of Washington
- The Executive Program, University of Virginia
- U.S. Army Command & General Staff College
- Program Management, Defense Systems Management College (DSMC)
- Senior Management Seminar & Boeing Management University @ The Boeing Company

**Industrial Background**
- HITCO Carbon Composites, Chief Operating Officer & Executive Vice President; 4 ½ Years
- The Boeing Company, Senior Business Manager, 32 years

**Military Service**
- Colonel, U.S. Army Reserve Retired
Agenda

• Carbon Fiber Overview and Advanced Composites Structures (CFRP) as a whole
  – Production Processes
  – Markets and Products
  – Business Trends & Challenges
  – Companies Involved
• Major Business / Economic Drivers
• Risks (Pitfalls) of achieving global success
• Summary
• Sources
About 22 lbs of PAN precursor is required to produce 9.9 lbs of carbon fiber.

- **Precursor required to produce Carbon Fiber (sold in the market in the form of a tow/yarn to make composite materials):** Small Tow & Large Tow
- **Precursors (such as PAN/PAN Pitch/Rayon) & Resin Matrices**
  - Prepregs / Composite Materials
    - Fabrics
    - Unidirectional (Unitape)
    - BMI
  - Manufacturing Processes
    - Direct Conversion
      - Pultrusion
      - Filament Winding
      - Carbon Carbon Composites (CCCs)
    - Intermediate Processes
      - Textiles (Bi-directional, Unidirectional, 3D, Braiding, and Multiaxial)
      - Prepregs
      - Moulding compounds
  - Moulding Technologies
    - Wet Hand lay-up
    - Vacuum bagging
    - Resin Transfer Moulding (RTM)
    - Resin Film Infusion (RFI)
    - Autoclave
    - Compression
    - Injection
    - Thermoforming
    - Mandrel wrapping

- Carbon Fiber Reinforced Polymer / Plastics (CFRP) is produced following the conversion of PAN into carbon fiber & addition of Resin Matrices
- Major costs in the manufacturing of CFRP are the precursor and energy consumed in the stabilization and carbonization of the fibers

Manufactured Composites supporting Aerospace & Defense, Space, Industrial and Sports & Leisure

## Market Definition

### Aerospace & Defense
- Civil Aircraft
  - Large Passenger Aircraft
  - Business Jets
  - General Aviation Sector
  - Commercial Freight Aircraft
- Military Aircraft
- Helicopters
- Unmanned Air Vehicles (UAVs)
- Space Systems (Including Launch Vehicles and Satellites)
- Missiles
- Jet Engines
- Marine
- Defense Vehicles & Armor

### Industrial
- Automotive
  - Brakes
  - Frames, hoods, fenders
  - Drive Shafts
  - Body Panels & Seat Backs
- Civil Engineering
  - Concrete/cement Reinforcement
  - Retrofitting of Bridges/tunnels
  - New building construction
  - Cables
- Offshore Oil & Gas
  - Drill risers
  - Production risers
  - Choke & kill lines
  - Auxiliary lines
  - Tendons / Tethers
- Pressure Vessels (Bulk Storage, Hydrogen)
- Wind Energy
- Other Industrial (Medical, Centrifuges)

### Sports & Leisure
- Golf Equipment
- Racquets
- Ski Poles and Snow Boards
- Fishing Rods
- Bicycles
- Marine
  - America’s Cup
  - Hyper Yachts
  - Spars and Masts
  - Gurit’s C-Boat Yacht

*Source: CompositesWorld, 9/22/2009*
Projected Worldwide Annual Demand for Global Carbon Fiber By Major Markets

- **Tons, Thousands**
- **Source:** The Carbon Fibre Industry Worldwide 2008-2014 by Tony Roberts
Usage of Materials in Civil Aircraft Structures, by Major Aircraft Type, 2008

Source: The Carbon Fibre Industry Worldwide 2008-2014 by Tony Roberts
World’s Airlines projected to lose $11B in 2009 and $4B in 2010.
<table>
<thead>
<tr>
<th>Period</th>
<th>Period</th>
<th>Trough</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recession of 1960-1</td>
<td>April 1960–Feb 1961</td>
<td>10 Months</td>
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<tr>
<td>Early 1980s recession</td>
<td>July 1981–Nov 1982</td>
<td>16 months</td>
</tr>
<tr>
<td>Early 1990s recession</td>
<td>July 1990–March 1991</td>
<td>8 months</td>
</tr>
<tr>
<td>Early 2000s recession</td>
<td>Mar–Nov 2001</td>
<td>8 months</td>
</tr>
<tr>
<td>Late 2000s recession</td>
<td>Dec 2007–TBD</td>
<td>Undertermined</td>
</tr>
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</table>

Total National Defense

Federal Outlays for Defense, NASA, and Aerospace Products & Services in

$ s in Billions

Source: Aerospace Facts and Figures 2008
By Aerospace Industry Association (AIA)
Economics: U.S. Total Civil and Military Aircraft Shipments for Years 1983 - 2007

Civil Shipments includes all Transports, Helicopters, and General Aviation both Domestic & Export. Military Aircraft Shipments include U.S. Military Agencies and Exports

Source: Aerospace Facts and Figures 2008
By Aerospace Industry Association (AIA)

The global carbon fiber industry experienced dynamic growth from 2003 – 2007. Production could not keep pace with market demand which led to higher prices. The Carbon Fiber industry responded with major investments in new plants to meet projected market requirements.

Market growth from 2008 to 2009 to date have slowed from previous years, and key market expectations from Aerospace & Defense sectors have not provided the projected growth required for increasing industrial capacity and significant cash outlays. Excess supply and pressure of falling prices and delays of bringing on new plants are ongoing challenges within the industry.

Market growth is expected to recover in 2010 to 2011 time periods for increasing usage of carbon fiber composites and its applications:

- Commercial Aviation
  - Civil
  - Regional
  - Business Jets
  - General: Personal/Individual
- Military Aviation: Cargo, Surveillance, UAVs, Tactical Fighters, Strategic Bombers (B-52, B1B and B2)
- Space: Commercial Launches / Government (NASA) development of Aries I through V
- Civil Infrastructure, Sports & Leisure, and Automobile
• Demand for Bi-directional fabrics continues to grow well into the next decade
  – Industrial sector applications are strong for wind energy, marine and automotive applications
  – Aerospace growth continues to grow due to existing commercial aviation platforms such as the Boeing 777 / 757 and the Airbus A340 / A330, which depends mainly on fabrics

• Next generation of Commercial Aviation platforms such as the Boeing 787, Airbus A380 and the yet-to-be-built Airbus A350 XWB will use mainly unidirectional prepreg tape
  – Hand Lay-up
  – ATL
  – AFP
• Major expansion programs between 2007-2013 for PAN-Based and Pitch-Based Carbon Fiber (small and large tow) manufacturers have been delayed due to the recession and lack of major schedule achievements of B 787, A380, A350 XWB, F-35 (JSF), along with stagnant growth in the Space markets.
  – Growth in demand from 2003 – 2005 grew at a rate of about 15% - 20%
• Major Manufacturers of Carbon Fiber
  – Pan small tow producers
    • Toray Industries Inc.
    • Toho Tenax Co. Ltd
    • Mitsubishi Rayon Co. Ltd.
    • Hexcel Corp.
    • Formosa Plastics Corp.
    • Cytec Engineered Materials Inc.
  – PAN large tow producers
    • SGL Group, The Carbon Co.
    • Zoltek Companies Inc.
  – Pitch carbon fiber producers
    • Mitsubishi Chemical Corp
    • Nippon Graphite Fiber Corp.
    • Cytec Engineered Materials Inc.
Estimated Annual Capacity in 2010
Of Global Carbon Fiber Production

Tons, Thousands

Source: CompositesWorld
and compiled by HPC in 12/2008
According to the U. S. Census Bureau, this industry had 351 firms employing 14,716 employees with a payroll of more than $586 million in 2001. The majority of these establishments employed fewer than 100 employees. The Annual Survey of Manufactures reported that more than 9,000 workers in this industry were in production; 2000 total shipments were valued at $4.8B but in 2001 total shipments were valued at $2.2B.

Source: The Carbon Fibre Industry Worldwide 2008-2014 by Tony Roberts
**Projected Fiber Usage in Conversion/Processing, 2007-2014**

- **Major growth drivers in unidirectional prepreg are:**
  - Aerospace & Defense
  - Wind Energy

- **Carbon Carbon Composites (CCCs):**
  - Large tow fibers (40 k to 320 k) are ideal for pultrusion. These fibers offer cost savings and a competitive advantage for pultruded parts: sporting goods and industrial components
  - Emerging applications are in wind energy, offshore cables and umbilicals for oil well exploration, electrical transmission cables tendons & tethers, and civil engineering/infrastructure

Source: The Carbon Fibre Industry Worldwide 2008-2014 by Tony Roberts
Projected Annual Capacity and Output
Of Small Tow PAN-based Global Carbon Fiber

Source: The Carbon Fibre Industry Worldwide 2008-2014 by Tony Roberts
Projected Annual Output Of Small and Large Tow PAN-based Global Carbon Fiber

Source: The Carbon Fibre Industry Worldwide 2008-2014 by Tony Roberts
### Leading Companies Active in the Weaving Sector, by Region

<table>
<thead>
<tr>
<th>USA</th>
<th>Europe</th>
<th>Country</th>
<th>Rest of World</th>
<th>Country</th>
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<tbody>
<tr>
<td>Hexcel</td>
<td>Hexcel</td>
<td>France</td>
<td>Taiwan Electric</td>
<td>Taiwan</td>
</tr>
<tr>
<td>Textile Products</td>
<td>Cramer</td>
<td>Germany</td>
<td>Arisawa Mfg</td>
<td>Japan</td>
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<tr>
<td>Fabric Developments</td>
<td>Porcher</td>
<td>France</td>
<td>Sakai Composite</td>
<td>Japan</td>
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<tr>
<td>Albany Techniweave</td>
<td>Sigmatex</td>
<td>UK</td>
<td>Sakai Oven</td>
<td>Japan</td>
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<tr>
<td>Sigmatex</td>
<td>Seal</td>
<td>Italy</td>
<td>You Chang Carbon</td>
<td>S. Korea</td>
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<tr>
<td>Barrday</td>
<td>Chomarat</td>
<td>France</td>
<td>Shou Chuang</td>
<td>China</td>
</tr>
<tr>
<td>Fiber Materials</td>
<td>SGL Technic</td>
<td>Germany</td>
<td>Friway North Industry</td>
<td>China</td>
</tr>
<tr>
<td>J B Martin</td>
<td>Carr Reinforcement</td>
<td>UK</td>
<td>Dalian Xingke Carbon Fiber</td>
<td>China</td>
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<tr>
<td>BGF Industries</td>
<td>G Angeloni</td>
<td>Italy</td>
<td>Yixing Huaheng High Performance Fiber Textile</td>
<td>China</td>
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<tr>
<td>Cytec</td>
<td>Fothergill Engineered Fabrics</td>
<td>UK</td>
<td>Yixing Xinwei Carbon Fiber Weaving</td>
<td>China</td>
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<tr>
<td>Ten Cate</td>
<td>Netherlands</td>
<td></td>
<td>Jiangsu Yuji Carbon Fiber Sci-Tech</td>
<td>China</td>
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<tr>
<td>Formax</td>
<td>UK</td>
<td></td>
<td>Haining Chengrudan Reinforcement Fabric</td>
<td>China</td>
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<td>Tekimpianti SpA</td>
<td>Italy</td>
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# Major Manufacturers of Multiaxial and 3D Fabrics by Region

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<tr>
<th>USA</th>
<th>Europe</th>
<th>Country</th>
<th>Rest of World</th>
<th>Country</th>
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<tr>
<td>Sigmatex</td>
<td>Sigmatex</td>
<td>UK</td>
<td>Lintex</td>
<td>China</td>
</tr>
<tr>
<td>Vectorply Corp</td>
<td>Hexcel</td>
<td>France</td>
<td>Dalian Xingke Carbon Fiber Co Ltd</td>
<td>China</td>
</tr>
<tr>
<td>V2 Composites Inc</td>
<td>Saint Gobain</td>
<td>France</td>
<td>Chrong Yi Co Ltd</td>
<td>Taiwan</td>
</tr>
<tr>
<td>OCV Reinforcements</td>
<td>Suertex</td>
<td>Germany</td>
<td>Kush Synthetics Pvt Ltd</td>
<td>India</td>
</tr>
<tr>
<td>3Tex Inc</td>
<td>Kumpers</td>
<td>Germany</td>
<td>Mytex Composites</td>
<td>Turkey</td>
</tr>
<tr>
<td>Bally Ribbon Mills</td>
<td>Formax</td>
<td>UK</td>
<td>Zongheng New Materials Technology Ltd</td>
<td>China</td>
</tr>
<tr>
<td>Selcom Srl</td>
<td>Italy</td>
<td></td>
<td>Jiangsu Aosheng Composites Materials Hi-tech Co Ltd</td>
<td>China</td>
</tr>
<tr>
<td>Seal</td>
<td>Italy</td>
<td></td>
<td>Jiangsu Yujie Carbon Fiber Sci-Tech Co Ltd</td>
<td>China</td>
</tr>
<tr>
<td>Devold AMT</td>
<td>Norway</td>
<td></td>
<td>Nanjing Hitech Composites Co Ltd</td>
<td>China</td>
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<tr>
<td>Angeloni Srl</td>
<td>Italy</td>
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<td>Wuzi Fusheng Insulation Materials Co</td>
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<td>Sphere Tex</td>
<td>Germany</td>
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<td>Yixing Huaheng Performance Fiber Textiles Co Ltd</td>
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<tr>
<td>Seal SpA</td>
<td>Italy</td>
<td></td>
<td>Yixing Xinwei Carbon Fiber Weaving Co Ltd</td>
<td>China</td>
</tr>
</tbody>
</table>
Carbon Fiber Demand for Carbon Fabrics, 2007 - 2014

Tons, Thousands

Source: The Carbon Fibre Industry Worldwide 2008-2014 by Tony Roberts
• As stated above, a carbon fiber prepreg consists of a combination of a matrix (or resin) and carbon fiber reinforcements, forming a “ready to use” component in composite manufacturing.

• Prepreg usually comes in two forms:
  – Unidirectional (UD) form (all the carbon fiber rovings in one direction)
  – Fabric form (several directions of reinforcement)
Carbon Fiber Overview and Advanced Composites Structures as a whole

Major Manufacturers of Prepregs by Region

<table>
<thead>
<tr>
<th>USA</th>
<th>Europe</th>
<th>Rest of World</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toray America (1)</td>
<td>Hexcel (1)</td>
<td>Mitsubishi Rayon (1)</td>
<td>Japan</td>
</tr>
<tr>
<td>Hexcel (1)</td>
<td>Cytel Engineered Materials (1, 2)</td>
<td>Toho Tenax (1)</td>
<td>Japan</td>
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<tr>
<td>Cytel Engineered Materials (1, 2)</td>
<td>Advanced Composite Group (Umeco) (1)</td>
<td>Toray Industries (1,2)</td>
<td>Japan</td>
</tr>
<tr>
<td>Newport Adhesives &amp; Composites (1)</td>
<td>Gurit (1)</td>
<td>Topkey Group (1)</td>
<td>Taiwan</td>
</tr>
<tr>
<td>Advanced Composite Group (Umeco) (1)</td>
<td>SGL Group (1)</td>
<td>Taiwan Strong (1)</td>
<td>Taiwan</td>
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<tr>
<td>Ten Cate (1,2)</td>
<td>Stesalit AG (1,2)</td>
<td>Hankuk Carbon Fiber (1)</td>
<td>S. Korea</td>
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<tr>
<td>Park Electrochemical (1)</td>
<td>SNPE Group (Strucll) (1)</td>
<td>SK Chemicals (1)</td>
<td>S. Korea</td>
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<tr>
<td>J D Lincoln (Umeco) (1)</td>
<td>Ten Cate (1,2)</td>
<td>Weihai Guangwei Group (1)</td>
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<tr>
<td>TCR Composites (1)</td>
<td>Seal Srl (1,2)</td>
<td>Jiangsu Aoosheng Composite Materials Hi-tech Co Ltd (1)</td>
<td>China</td>
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<tr>
<td>Performance Materials (2)</td>
<td>Teximpianti SpA (1)</td>
<td>Jiangsu Yujie Carbon Fiber Sci-tech Co Ltd (1)</td>
<td>China</td>
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<tr>
<td>Aidila (1)</td>
<td>ACG Primo Ltd (Umeco) (1)</td>
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</table>

1) Epoxy prepregs
2) Thermoplastics prepregs

- Carbon Fiber demand in the civil aviation sector is projected to grow significantly from 2010 through 2014.
- Unidirectional prepreg will account for 50% - 55% of this market through 2009, and increasing to 65% - 75% by 2014.
- Boeing and Airbus are the major drivers in the increasing demand of unidirectional prepreg and in future designs.
• Commercial Aviation ($3.2 trillion Market through 2026)
  – Civil
  – Regional
  – Business Jets
  – Personal/Individual

• Defense
  – F-35 (JSF)
  – UAVs

• Space
  – Aries I through V Development
Long-term Demand for New Commercial Airplanes Remains Strong

Firm Backlog at Boeing and Airbus will Allow Both to Operate at Peak Production Levels for Next 5+ Years

Source: The Boeing Company
Comparison of Twin-aisle Airplane Offerings to Meet Projected Market Requirements

Source: The Boeing Company
Aerospace & Defense Markets

Source: The Boeing Company

*Airbus claim
Aerospace & Defense Markets

Passenger Airplane Deliveries Forecast
2007 – 2026

BOEING

737-900ER
180 seats

737-800
162 seats

737-700
126 seats

737-600
110 seats

17,630 Seats

AIRBUS

A320-200
158 seats

A319-200
128 seats

A318
107 seats

15,330 Seats

Source: The Boeing Company
Demand by Size & Projected Sales Values 2009-2028

- **New Airplanes:** 29,000

  - Regional Jets
  - Single Aisle
  - Twin Aisle
  - Large

- **Value ($B):**
  - Large
  - Twin Aisle
  - Single Aisle
  - Regional Jets

**Key Assumptions**
- World GDP Growth rate 3.1%
- Passengers Traffic Growth rate 4.1%
- Cargo Growth Rate 5.4%
- Fleet Growth Rate 3.2%

**Source:** The Boeing Company
Aerostructure Composites: Major Elements of Growth Strategies

• Acquire capabilities / competences to close the gap.
  – Design Engineering: Tooling, manufacturing processes, qualification techniques, and Level III NDT Inspection Criteria & State of the Art NDT Equipment
  – Clean Room Expansion and Qualification
  – Refrigeration Storage Capacity of Prepregs (Maintaining shelf life)
  – Automated Tape Laying (ATL): Cincinnati Machine, M.Torres
  – Automated Fiber Placement (AFP): Cincinnati Machine, Torres, Ingersoll-Rand
  – Automated Noodle/Deltoid Machines
  – Upgrading of Production Facilities to accommodate equipment, clean rooms, tooling storage, and prepregs refrigerated materials storage
  – Automated Gerber Ply Cutters & Virtek Laser Ply Locators with projectors
  – Water Jet Cutter Equipment
  – Large Autoclave capability along with Out-of-the-Autoclave (OOA) capability with Ovens
  – Painting and Trim & Drill (Bertsche & 5 Axis SNK Machines) Centers of Excellence
  – Factory Upgrades to maximize Lean Manufacturing Flows within factory

• Strategic Agreements/Qualification Sponsorships with Commercial Tier I suppliers supporting Boeing, Airbus, and Regional Jet Manufacturers to secure Long-Term “Production Carve out” Contracts.

• Balance growth via production opportunities with key Prime Contractors within the DoD and Space markets.
Best in the class Tier I/II/III Aerostructures fully automated supplier for commercial & general aviation, military and space applications

### Key Products
- Tail Cones & Fuselages
- Controlled Surfaces
- Complex IML/OML
- Pressurized Bulkheads
- Services

### Markets & Qualification Requirements
- **Commercial/General Aviation**
  - **Commercial Aviation Programs**
    - Current
    - Pursuits
  - **General Aviation Programs**
    - Current
    - Pursuits

- **Military Domestic/Foreign**
  - **Domestic Programs**
    - Current
    - Pursuits
  - **Foreign Programs**
    - Current
    - Pursuits

- **Space Domestic/Foreign**
  - **Domestic Programs**
    - Current
    - Pursuits
  - **Foreign Programs**
    - Current
    - Pursuits

### Core Competencies/Intellectual Property/Infrastructure/Human Capital

Aerospace & Defense Markets

Automate, or Immigrate, or Evaporate

Source: The Boeing Company

Large Autoclaves
30’ X 60’ or 20’ X 50’

5 Axis SNK

Water Jet Cutter

Automated Noodle Machines

Precision Control of Debond Fabrication
Unidirectional Prepreg Tape In growing Use via Automation Manufacturing

Automated Fiber Placement (AFP)

• B 787 Fuselage Sections, Tail Cone
• V22 Sponsons
• V22 Aft Fuselage
• V22 Side Skins
• F35 Wing Skins
• F35 Inlet Duct Systems
• UAV Wing Skins
• etc

Automated Tape Laying (ATL)

• B 787 Floor and Cargo Beams
• B 787 Controlled Surfaces: VTP, Wing Surfaces
• Pressurized Bulkheads and Door Skins
• A380 VTP and HTP Ribs
• A350 Wing & Fuselage Skins
• A400 Wing Spars
• I-Beams and Floor Beams
• Launch Rails
• etc

One of the most versatile and sophisticated machinery designs ever created by any industry, VIPERs enable independent control over feed, clamp, cut and start for up to 32 individual tows or slit tape. This allows automated "on-the-fly" adjustment of fiber band width, controlled bending of fiber layout around changing contours, and precise configuration of openings (doors, hatches, etc.). The multi-strand control allows wrinkle-free, near-net shape lay-up of enclosed and deeply contoured structures and concave/convex surfaces, enabling precision production of fuselage sections, panels, cowls, ducts, and nozzle cones for commercial, military and space vehicles.

ATL perform automated lay-up with wider graphite/epoxy tape material. A fifth-generation head delivers the market’s highest productivity and consistency. Separate ATL models are available for automated lay-up of contoured (up to 25°) and flat shapes, and long, narrow structural parts.
A380 Composites
## Aerospace & Defense Markets

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<tr>
<th></th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
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<th>2014</th>
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<td><strong>787 Build Rate</strong></td>
<td>5</td>
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<td>5</td>
<td>30</td>
<td>50</td>
<td>70</td>
<td>90</td>
<td>120</td>
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<tr>
<td><strong>Carbon Fiber (Tons)</strong></td>
<td>149</td>
<td>149</td>
<td>149</td>
<td>893</td>
<td>1,488</td>
<td>2,083</td>
<td>2,680</td>
<td>3,575</td>
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<tr>
<td><strong>A380 Build Rate</strong></td>
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<td>12</td>
<td>14</td>
<td>20</td>
<td>25</td>
<td>30</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td><strong>Carbon Fiber (Tons)</strong></td>
<td>130</td>
<td>305</td>
<td>355</td>
<td>510</td>
<td>635</td>
<td>762</td>
<td>888</td>
<td>1,015</td>
</tr>
</tbody>
</table>

Source: The Carbon Fibre Industry Worldwide 2008-2014 by Tony Roberts
B 777 Design Changes
To make use of more
Composites, B 777 Light?

Composites
- Floor Beams
- Stringers
- Wing-to-body Fairings
Aerospace & Defense Markets

2,400 U.S. Buy
1,600 Europe

Global Hawk

UCAS-D

Reaper (Predator B)

BAMS

USS Stiletto,
Entirely from CFRP

Aerospace & Defense Markets

Aries I – V Development and Production: Next key 5 years R & D next generation Rocket Program Involving Composites

Core Stage
- Six Delta IV-derived RS-68B LOX/LH$_2$ engines (expendable)
- 10 m (33 ft) diameter stage
- Composite structures
- Aluminum-Lithium (Al-Li) tanks

Earth Departure Stage (EDS)
- One Saturn-derived J-2X LOX/LH$_2$ engine (expendable)
- 10 m (33 ft) diameter stage
- Aluminum-Lithium (Al-Li) tanks
- Composite structures, Instrument Unit and Interstage
- Primary Ares V avionics system

Payload Adapter

Payload Shroud

Altair Lunar Lander

J-2X

Loiter Skirt

Interstage

Solid Rocket Boosters (2)
- Two recoverable 5.5-segment PBAN-fueled, steel-casing boosters (derived from current Ares I first stage)

RS-68B Engines (6)
• Continual production delays and falling orders for B 787, A350 XWB, and A380
  − Impact to capital requirements for expansion of new plants & equipment
  − Excess capacity and falling prices
  − Cash flow problems
  − Prices increases post recovery
• Economic recovery that looks like the recessions of the 1980s: W-shaped recessions impacting Industrial Sector
• Delays in Joint Strike Fighter
Carbon Fiber industry has experienced significant growth. Market growth is expected to recover in 2010 to 2011 time periods for increasing usage of carbon fiber composites and its applications and manufacturing supporting Aerospace & Defense, Industrial & Auto, and Sports & Leisure markets.

Increasing opportunities for industrial collaboration such as the announcement of Cytec Engineering Materials and Mitsubishi Rayon developing advance carbon fiber composites.

Lessons learned from B 787 and A350 XWB platforms will transform the future redesign of single aisle planes (737/A320) using 50%+ carbon fiber/Composites.

The industry should be judged (and price based) on the results and wealth it creates for its customers. Growth for the sake of growth is not a strategy for long term profitability. The carbon fiber industry has answered the calling.
Sources

• The Boeing Company
• Airbus
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