# Aerospace Structural Material Certification

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# Boeing Products





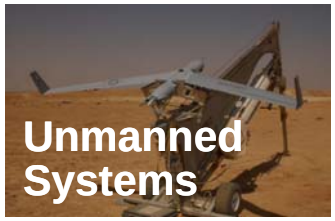


***Boeing Commercial Aircraft***







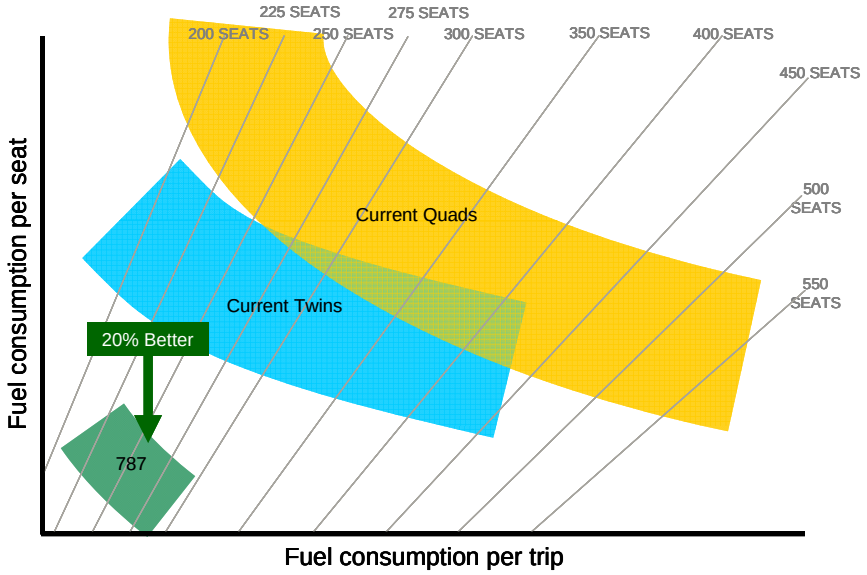







***Boeing Defense, Space, and Security***

# Material Selection Drivers



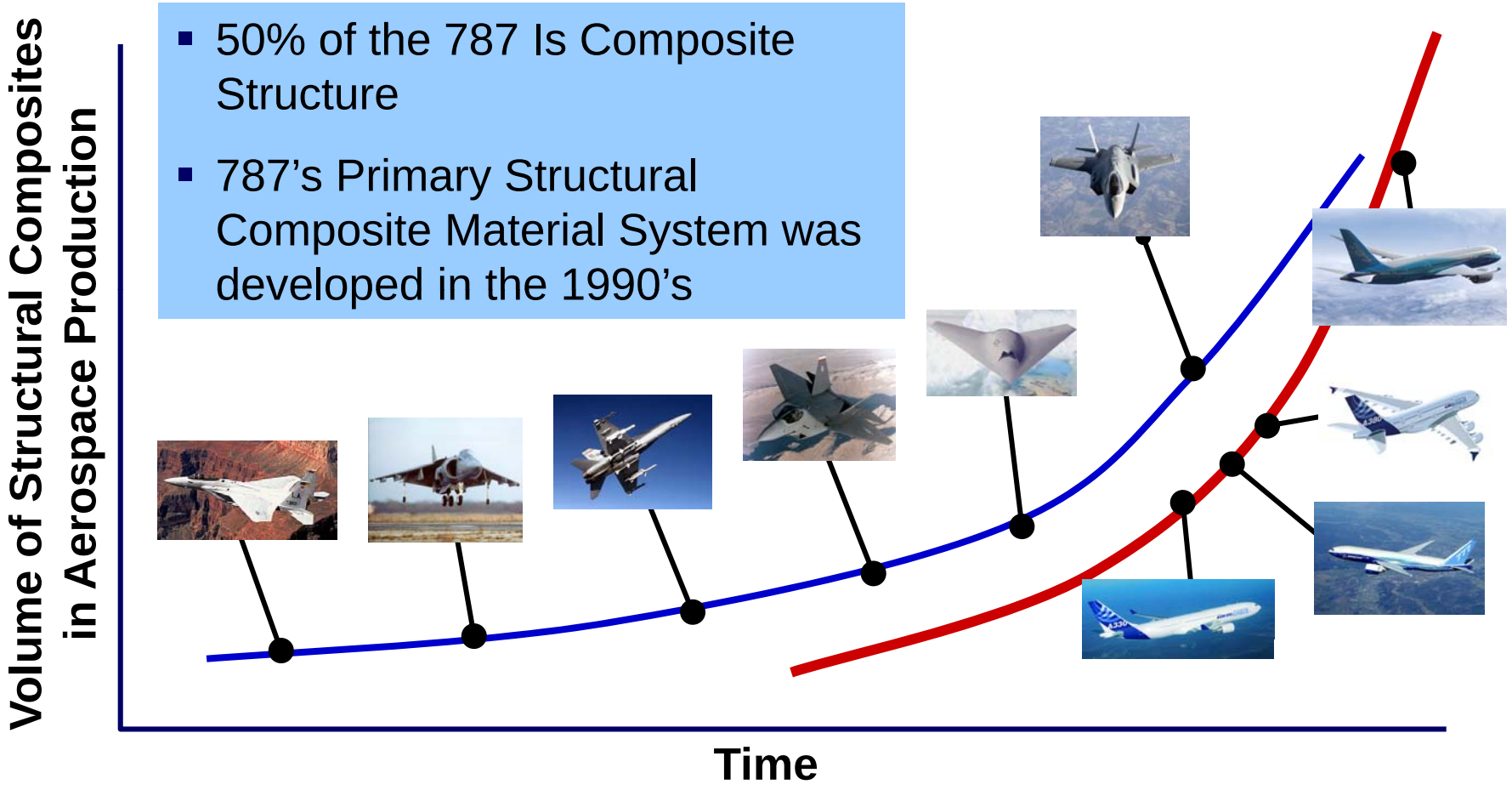

***Fuel Efficiency is Driving Commercial Focus on Structural Materials***

***Payload, Performance, and Cost are Driving the Boeing Defense Focus on Structural Materials***

**Performance Gains from Weight Reductions are Driving the Increased Usage of Composite Materials**

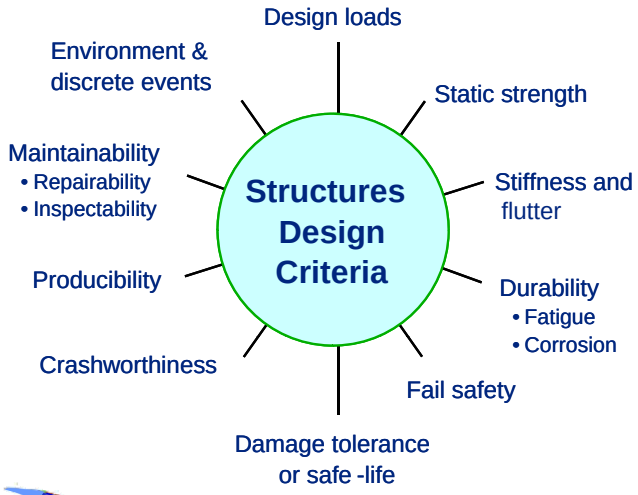
# Commercial Production Driving Increased Usage of Composite Materials

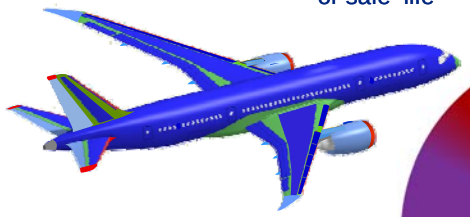
- 50% of the 787 Is Composite Structure
- 787's Primary Structural Composite Material System was developed in the 1990's

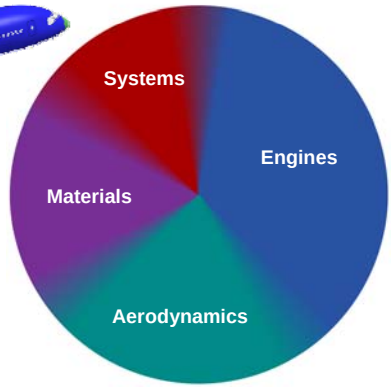



**Material Development Must Begin Well in Advance of Conceptual Design**

# A New Material System Must Earn Its Way onto the Airplane



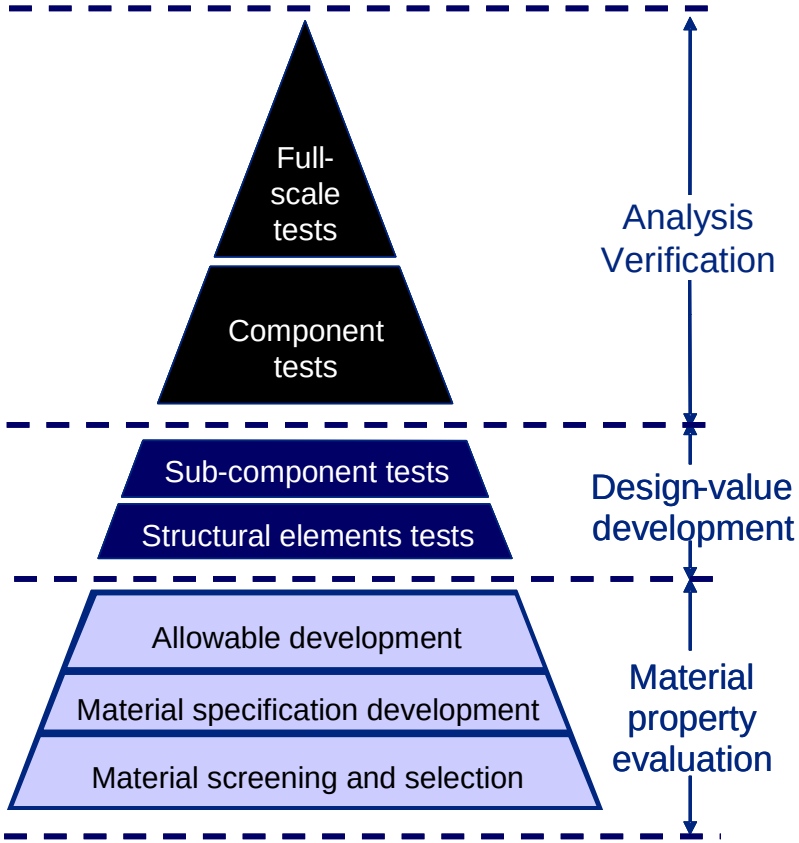






- **Targeted Application**
- **Breakthrough Performance Improvements**
  - Material Substitution
  - Reduced Minimum Gauge
  - System Level Functionality
- **Value / Affordability Across the Life Cycle**
  - Material Cost
  - Fabrication
  - Service

**Significant Improvements Must Be Realized to offset the Development and Certification Costs**

# Certification of New Material Systems

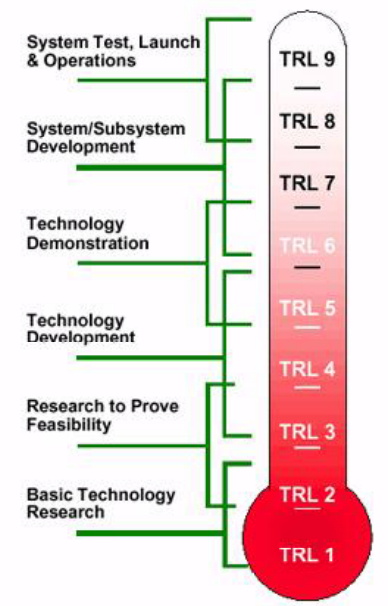



| Development Phase | Development Time |
|---|---|
| ▪ Modification of an existing material for a non-critical component | ▪ **2-3 years** |
| ▪ Modification of an existing material for a critical structural component | ▪ **Up to 4 years** |
| ▪ New material within a system for which there is experience | ▪ **Up to 10 years** – includes time to define the material's composition and processing parameters |
| ▪ New material class | ▪ **Up to 20 years or more** – includes time required to develop design practices that fully exploit the performance of the material and establish a viable industrial base |

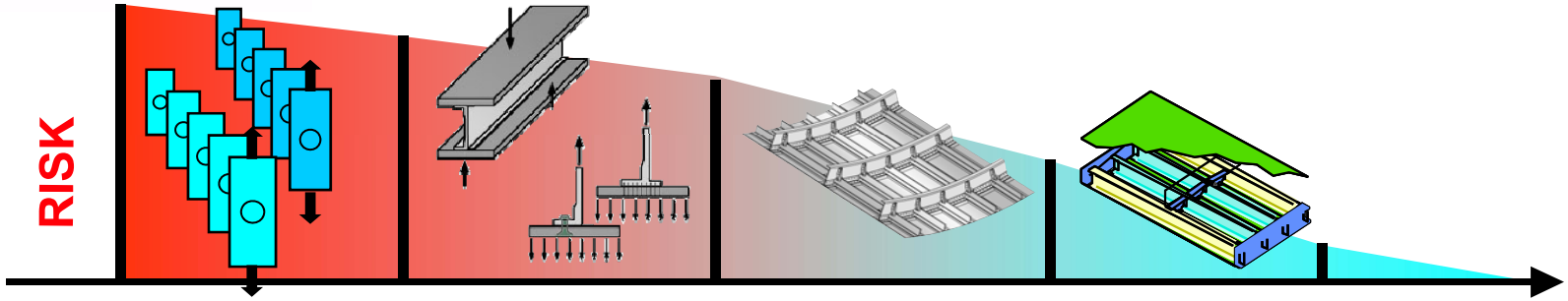
SOURCE: R. Schafrik, GE Aircraft Engines, Technology Transition in Aerospace Industry, briefing presented at the Worksop on Accelerating Technology Transition, National Research Council, Washington DC, November 24, 2003

**Significant Risk Mitigation is Required to Certify a New Structural Material**

# Blocking Block Approach to Materials Maturity and Risk Reduction

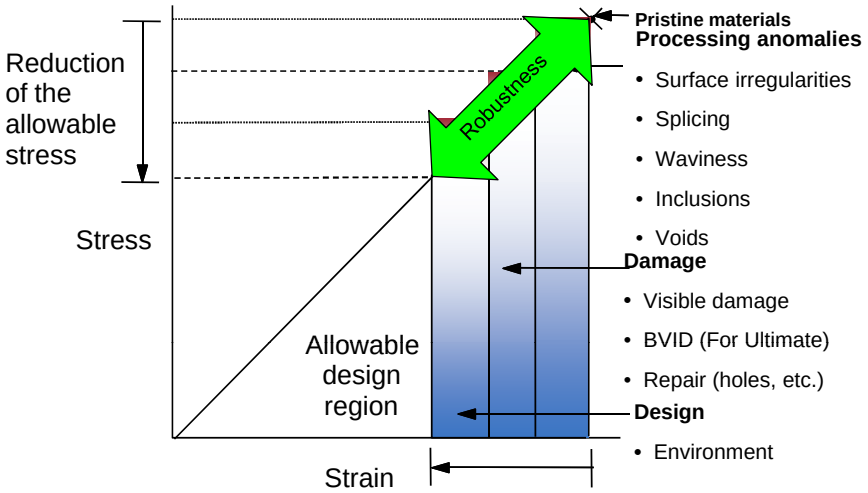



1. Basic Material Physical
2. Mechanical Properties
3. Process Feasibility
4. Material and Process Scalability - Specifications
5. Design Allowables & Subcomponent Article Demonstration
6. Critical Feature/Full Scale Component Testing




**Processing and Process Variability Can Significantly Impact Structural Performance**

# Material Processing Can Significantly Impact Structural Performance




- Scale and Complexity of Design Matter …Alot
- Processing Variability Impacts Weight Reduction Potential
- Materials Development Must Include Processing Needs
- Can the New Materials Be Used with an Existing Process or Is a New Fabrication Technique Required?
- Do the Support Materials Exist – Consumables, Adhesives, etc…

**Variability Impacts Both Processing and Structural Performance**

# Aerospace Requires Enhanced Quality Control in the Supply Base


**~80X more composites, by weight, in annual full-rate production of 787 than F-22**

- Industrial Scale Quantities
- Production Ready Equipment and Facilities
- Quality / Verification Control Capability
- Standardization of Testing
- Supplier Certification
- Expertise/Skill Base
- Cost
- Regulatory Compliance

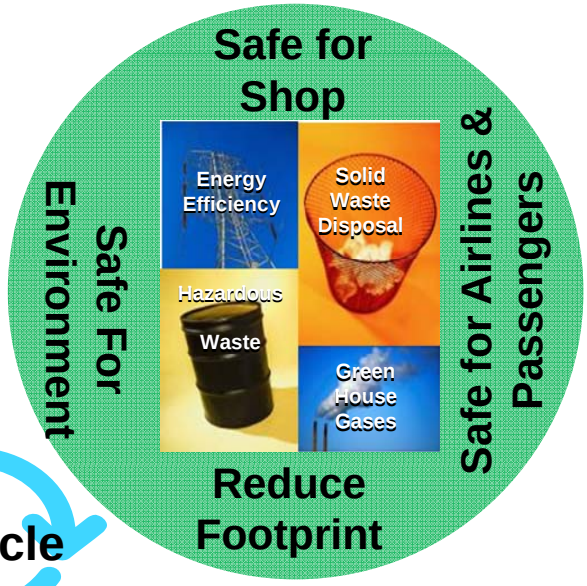
**Aerospace Manufacturers Need to Understand a Materials Impact Beyond Acquisition**

# A New Material System Needs to Be Understood Throughout Its Life Cycle

**Assembly**

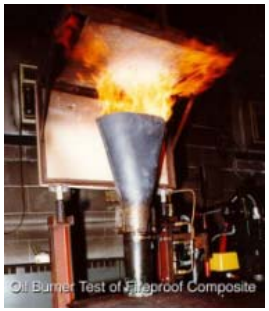
**Fabrication**

**Surface Preparation for Finishing**



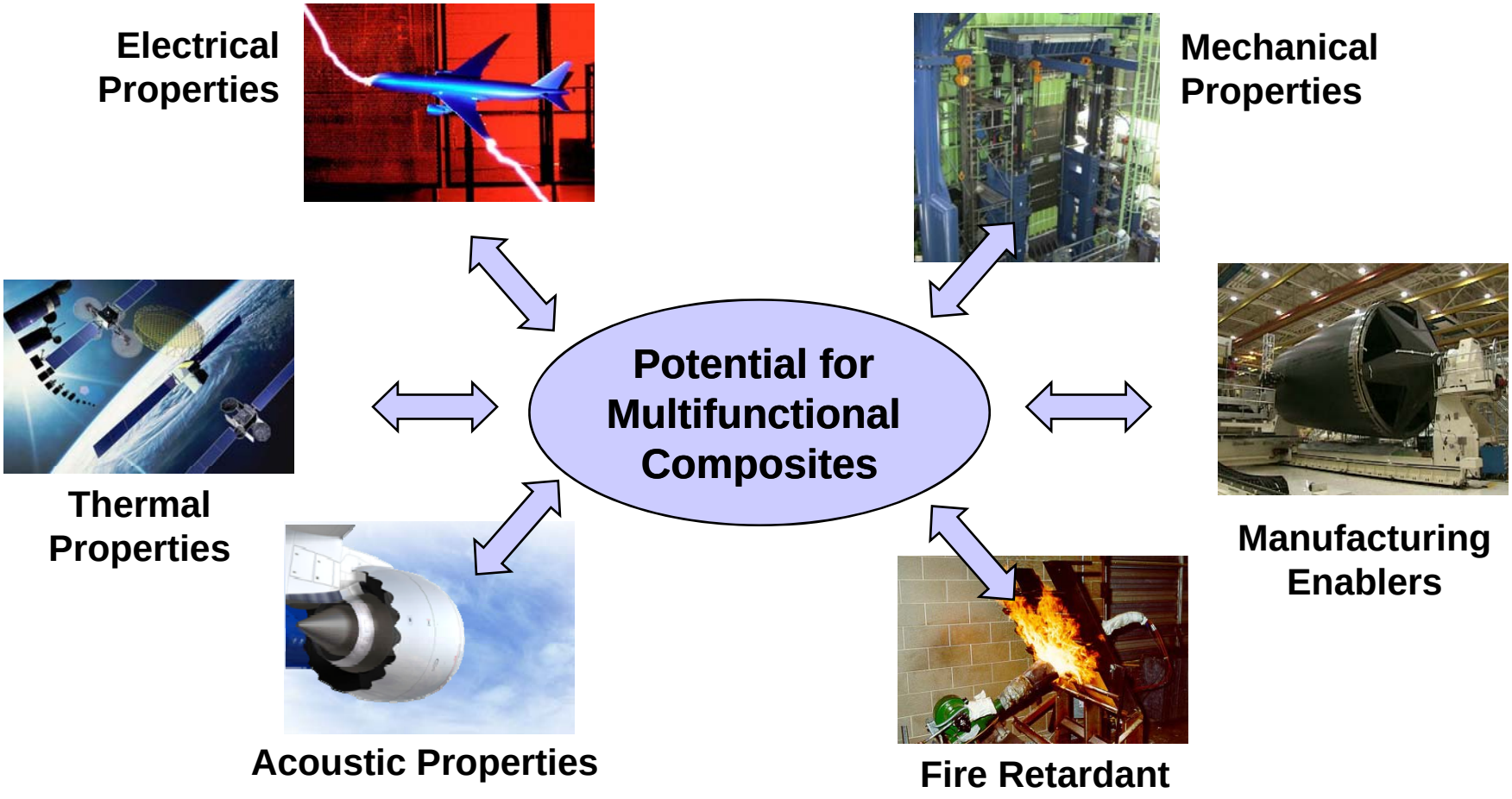

**Retire Part/Product**

**In-service Maintenance & Repair**



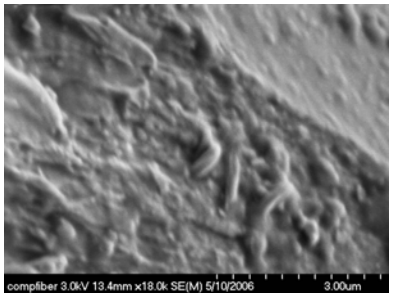

**NanoComposites Need to Be Safe and Meet Regulatory Compliance Throughout the LIfecycle**

# NanoComposites Have Tremendous Potential To Improve Our Systems

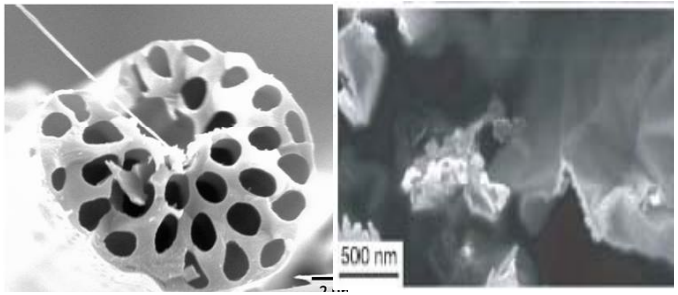



**Need to Demonstrate the Performance Feasibility of NanoComposites to Create the Necessary Pull**

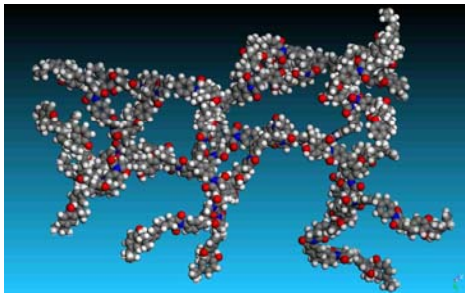
# Emerging Materials Focus




**Understand the Science**



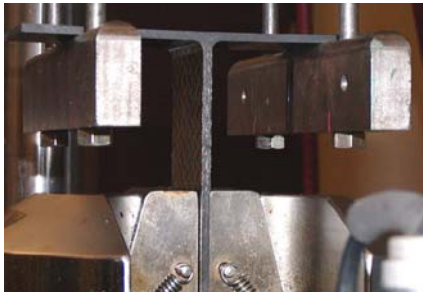

**Investigate and Mature New Material Forms**



**Modeling, Simulation, and Analysis will Accelerate the Adoption**

## "Engineered" Materials

**Functionality**

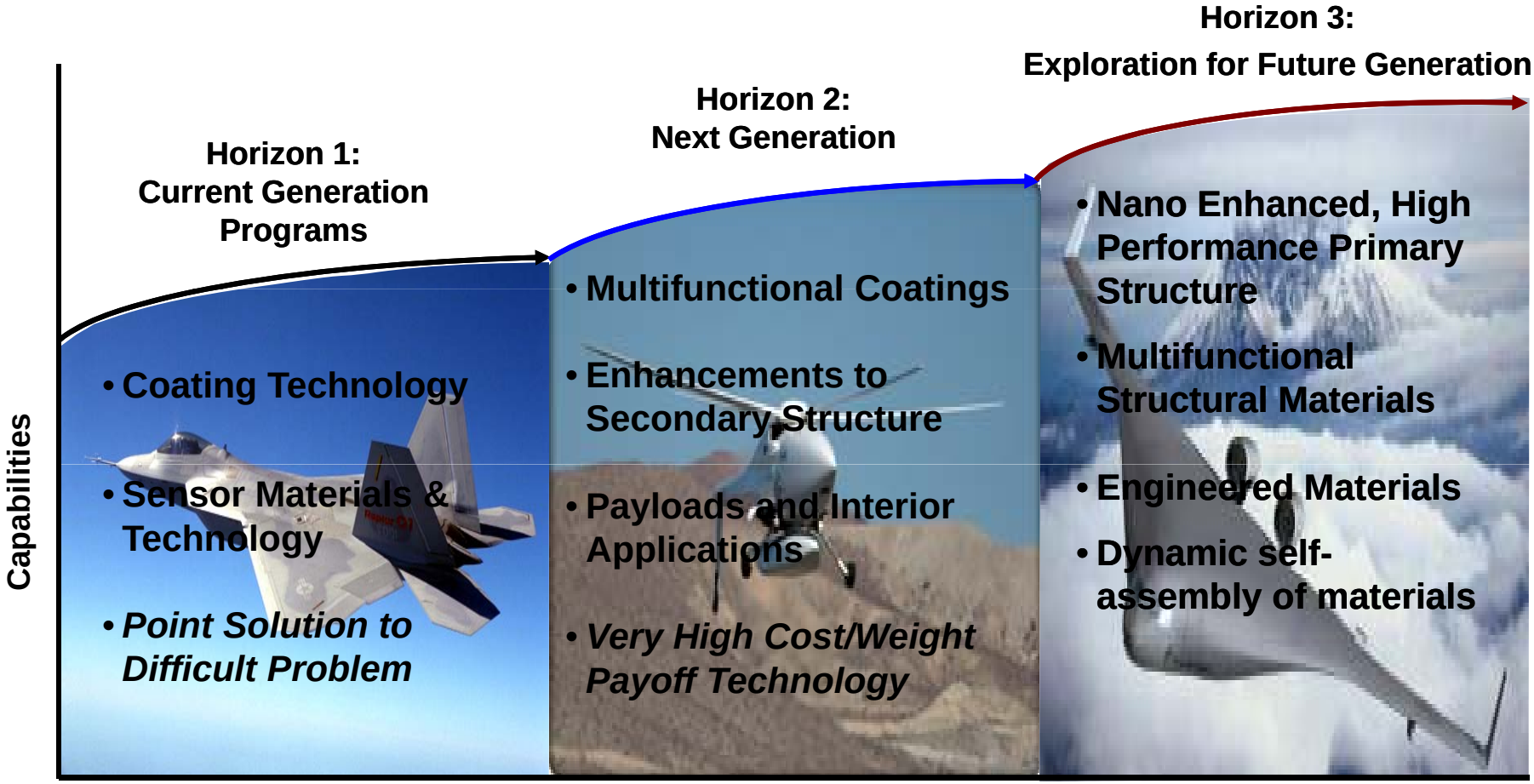


**Improved Structural Properties**

**Novel Processing**

**Enabling Engineered Materials for System Level Performance is Key**

# NanoComposites Transition Opportunities Across Time Horizons




***Implementation of NanoComposites is Likely to Be Incremental***

# Summary

- NanoComposites have significant potential
- Materials must earn their way onto the airplane
  - Significant Performance improvements required to offset development costs
- Aerospace use requires rigorous building block approach and quality control system
- Safety and Environmental issues are critical
- Implementation likely to be incremental (builds confidence and improves understanding)

# Thank You