Composites for Space Applications

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Remarks

- Welcome to Composite Conference 2012
- Special thanks and welcome to participants in the NASA Composite Summit that started this collaboration.
- Special Thank You!
  - Joshua Jackson (MKF), Harold Beeson (NASA), James Fekte (NIST) and Antonio Ruiz (DOE) for chairing the conference
  - Session chairs and all NASA and NIST staff who worked hard to organize the conference with MKF
  - New Mexico State DACC’s president Dr. Margie Huerta for hosting us in the East Mesa Facility
  - Angelique Lasseigne (G2M2) Crystal Lay (NMSU Mechanical and Aerospace Engineering) and Charles Nichols (NASA) for making STEM student sponsorship possible.
Why are we here?

- Need high strength materials in mass and cost constrained applications
  - Additional knowledge needed to use composites in our applications more efficiently
  - Non-homogenous material
  - Anisotropic structures
  - Viscoelastic response to loading
  - Multiple material interfaces

- Composite use in space systems requires
  - Advanced structural models
  - Life and failure mode prediction
  - Harmonized codes and standards
  - Materials and processes that address composite component variability
  - Reliable nondestructive evaluation
# NASA’s Use of Composites

**Future**  
NASA Space Technology Roadmaps  
Composite is Cross cutting technology, TA12, TA7

**Today**  
NASA’s COTS & CCDEV Vehicles  
Composite Pressure Vessels  
Composite Structure

**Today**  
Space Launch System  
Composite Pressure Vessels  
Composite Structure

**Today**  
Orion  
Composite Pressure Vessels

**1990s**  
International Space Station  
Composite Pressure Vessels

**1970s**  
Space Shuttle  
Composite Pressure Vessels  
Composite Wing Leading Edge

**1960s**  
Apollo  
Pre-composites

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**Future Composite Space Vehicles (NASA’s Composite Crew Module)**

**Growth in Composite use**
Crosscutting for Space Technology Roadmaps

- Composites are a crosscutting technology for NASA’s future missions.
  - Mars Precursor Missions & Heavy Lift Vehicle (2020)
  - Advanced In-space Propulsion (2025)
  - Space Platforms (2030)

- Information on technology roadmaps can be found at:
  [http://www.nasa.gov/offices/oct/home/roadmaps/index.html](http://www.nasa.gov/offices/oct/home/roadmaps/index.html)
# Composites Need: Space Technology Roadmap

## 2.1 Materials
- **2.1.1 Lightweight Structure**
  - Non-autoclave Composite
  - Hybrid Laminates
  - Tailorable (spec. strength, therm. Cond.)
- **2.1.2 Computational Design**
  - Micro Design Models
  - PMC Damage Models
  - Environment (time dependent degradation)
- **2.1.3 Flexible Material Systems**
  - Expandable Habitat
  - Flex. EDL Materials
- **2.1.4 Environment**
  - Cryo-Insulators
  - Ad. Ablator
  - Radiation/MMC
- **2.1.5 Special Materials**
  - Optical Materials (windows)
  - Repair
  - Sensor Materials
  - Space Suits

## 2.2 Structures
- **2.2.1 Lightweight Concepts**
  - Non-Autoclave Primary Struc.
  - Composite Allowables
  - Probabilistic Design Methodology
  - Composite/Infra
- **2.2.2 Design and Certification Methods**
  - Streamlined DAC Processes
  - Composite Allowables
  - High-fidelity Response Simulation
- **2.2.3 Reliability and Sustainment**
  - Predictive Damage Methods
  - Life Extension, Prediction
  - SHM, THM Integration
- **2.2.4 Test Tools and Methods**
  - Integrated Flight Test Data ID and Usage
  - Full-field Data Acquisition (non-contact)
  - Full-field Model V&V
  - Active Control of Structures
- **2.2.5 Innovative, Multifunctional Concepts**
  - Integrated Cryo tank
  - Integrated (non-pres) MMD
  - Integrated Window
  - Reusable Modular Components
  - Large Lightweight Stiff Dep

## 2.3 Mechanical Systems
- **2.3.1 Deployables, Docking and Interfaces**
  - Common Universal Interchangeable Interfaces
  - Deployment of Flex Materials
- **2.3.2 Mechanism Life Extension Systems**
  - Long Life Bearing / Lube Systems
  - Cryo Long Life Actuators
- **2.3.3 Electro-mechanical, Mechanical and Micromechanisms**
  - Robotic Assembly Tools/Interfaces
  - Cryogenic and Fluid Transfer
  - Active Landing Attenuation System
- **2.3.4 Design and Analysis Tools and Methods**
  - Kinematics & Rotor Dynamics Analysis
  - Precursor Flight High Rate Data for Design
- **2.3.5 Reliability / Life Assessment / Health Monitoring**
  - Relevant Environment Durability Testing (i.e. ISS)
  - Predictive Damage Methods
  - Embedded Systems
- **2.3.6 Certification Methods**
  - Loads & Environments
  - Test Verified Physics
  - Life Extension

## 2.4 Manufacturing
- **2.4.1 Manufacturing Processes**
  - PMC & MMC Processes
  - CMC Processes
  - Metallic Processes

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Accelerated Growth in Composites

- Barriers to Growth
  - Funding limitations
  - Cross disciplinary technological challenges
  - Maturity required to meet roadmap dates

- Steps to Accelerate Growth
  - U.S. intra-government collaboration
  - Government-industry partnerships
  - International communication and collaboration
  - Globally harmonized roadmaps for key technologies

NASA-Commercial Collaboration
Charlie Bolden (NASA) and Elon Musk: (Space X)
Let’s Go!

• Address the global challenge of using composites in our applications by addressing common issues
• Excited to meet with leaders who are advancing composites in their applications
• Keep up with a paradigm shift from metals to composites occurring in aerospace, automotive, marine, and pipelines

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