



# NASA Engineering Update

NDIA 16<sup>th</sup> Systems Engineering Conference  
Chief Systems Engineers Panel:  
*“Engineering in the Face of Uncertainty”*

29 October 2013

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NASA Chief Engineer

# Recent Accomplishments and Efforts



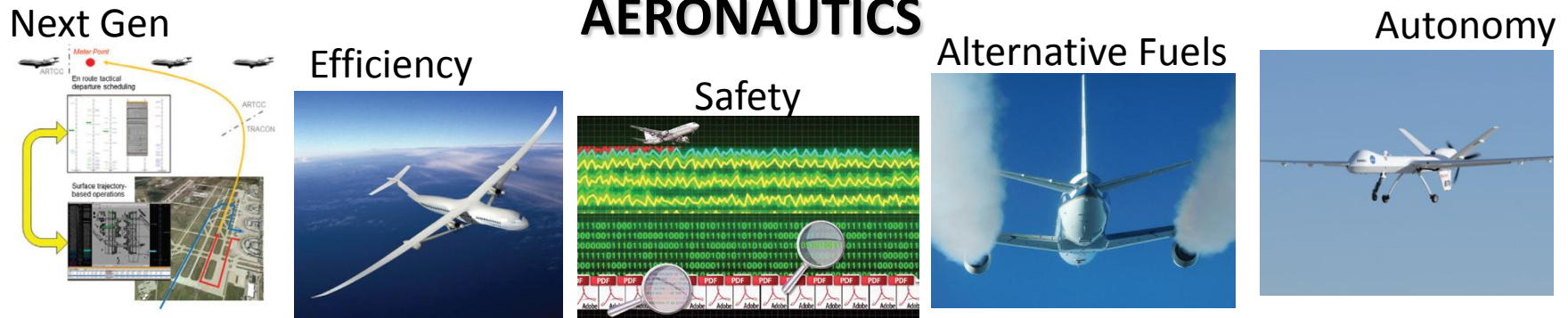
## SCIENCE



## EXPLORATION



## AERONAUTICS



**Near-Term Emphasis on Strategic Technology and Engineering Investment**

# Transition from Low Earth Orbit to Deep Space Missions Requires Revolutionary Approaches



The Moon



Asteroids  
& NEOs



Mars and its moons



International  
Space Station



250 miles

Today's strategy for LEO does not work for tomorrow's deep space missions

Today's Strategy: "The 4 R's"

Resupply;

Repair by replacement;

Redundant hardware;

Retreat to Earth

Minimum  
distance to Mars  
35,000,000 miles

For long duration spaceflight beyond LEO a new paradigm is needed – can basic research help?  
History demonstrates it has and will

# Challenges for Deep Space Exploration



Communication



Environment  
Control &  
Life Supporting  
Systems



Power  
Generation  
& Storage



Logistics



Navigation



Manufacturing  
In Space &  
For Space



Entry,  
Descent  
& Landing



Radiation  
Mitigation



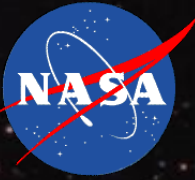
Propulsion

# Engineering Trends

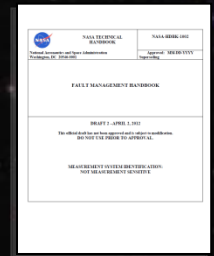
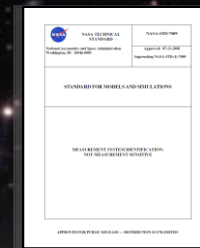


- **Model-Based Engineering/System Engineering**
  - Prevalent Throughout Agency, But Not End-to-End Lifecycle
- **Advanced Manufacturing**
  - National Center for Advanced Manufacturing (MSFC)
  - Structural Light-weighting
  - Additive manufacturing for complex, high stress components
- **Advanced Materials and associated analytical advancements**
  - Custom materials
  - Nano-Sensing
- **Autonomy**
  - Control: System, Guidance and Navigation, Precision Landing
  - Health-Monitoring and Correction

# Recent Engineering Initiatives



- Modeling and Simulation Standard and Handbook
- Fault Management Handbook
- ARMD Composites Initiative
  - Drastic Reduction in Material Certification and Product Development times and costs
- NASA Integrated Model-Centric Architecture
  - Building an Agency-Wide Infrastructure for Migration to Model-Based Environment



# Inter-Agency Engineering Collaboration

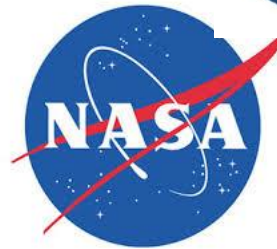
**IAWG**  
Inter-agency Working Group

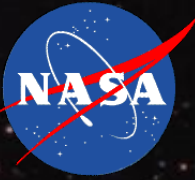
*“...envisioning a future in which large, technologically path-breaking engineering projects are undertaken regularly, are almost always successful, and are routinely accomplished on time and within budget...”*

- Leveraging Resources, Knowledge and Ideas
- Affect a National Shift in Engineering

**NIST**

**DARPA**





# Future Directions & Questions

- Engineering of systems and formal methods
  - What replaces requirements flows and decomposition in model and simulation based development
  - How fast/far can we go in eliminating testing
- Formal Methods for Optimizing the Architecture of Complex Systems
  - Fault Management and Isolation
  - Containment of Un-Anticipated Behaviors
- Engineering with Advanced Materials
  - Can we design smart materials to need, know their properties and how to insert them in our development flows
  - Embedded Micro/Nano-Sensors – how to handle the information
- Bio-Enabled Design / Synthetic Biology
  - Complementing chemical engineering
  - What do computational methods look like
  - How does this change our engineering processes



- **In the face of uncertainties we must not lose sight of our fundamentals but neither can we be prisoners to the past**
- **Engineering advancements in tools and methodologies will be required to capitalize on research and technology advancements**
- **In this environment, advancement will be slowed so we must be steady and ready to seize opportunities**
- **Collaboration and Cooperation are ESSENTIAL**