



NASA Engineering Update

NDIA 16th 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



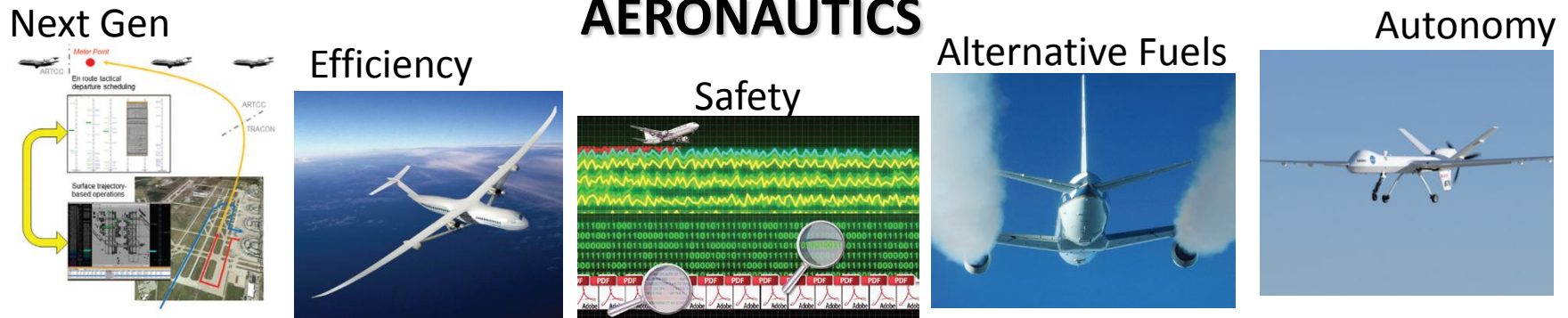
SCIENCE



EXPLORATION



AERONAUTICS



Near-Term Emphasis on Strategic Technology and Engineering Investment

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



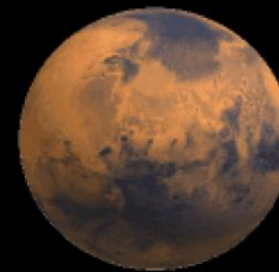
The Moon



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

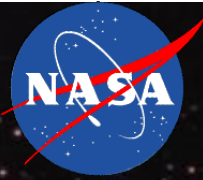


Radiation
Mitigation



Propulsion

Engineering Trends

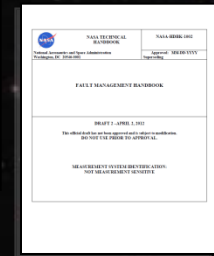


- **Model-Based Engineering/System Engineering**
 - Prevalent Throughout Agency, But Not End-to-End Lifecycle
- **Advanced Manufacturing**
 - National Center for Advanced Manufacturing (MSFC)
 - Structural Light-weighting
 - Additive manufacturing for complex, high stress components
- **Advanced Materials 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**