
Aeronautics Committee Report to the NASA Advisory Council

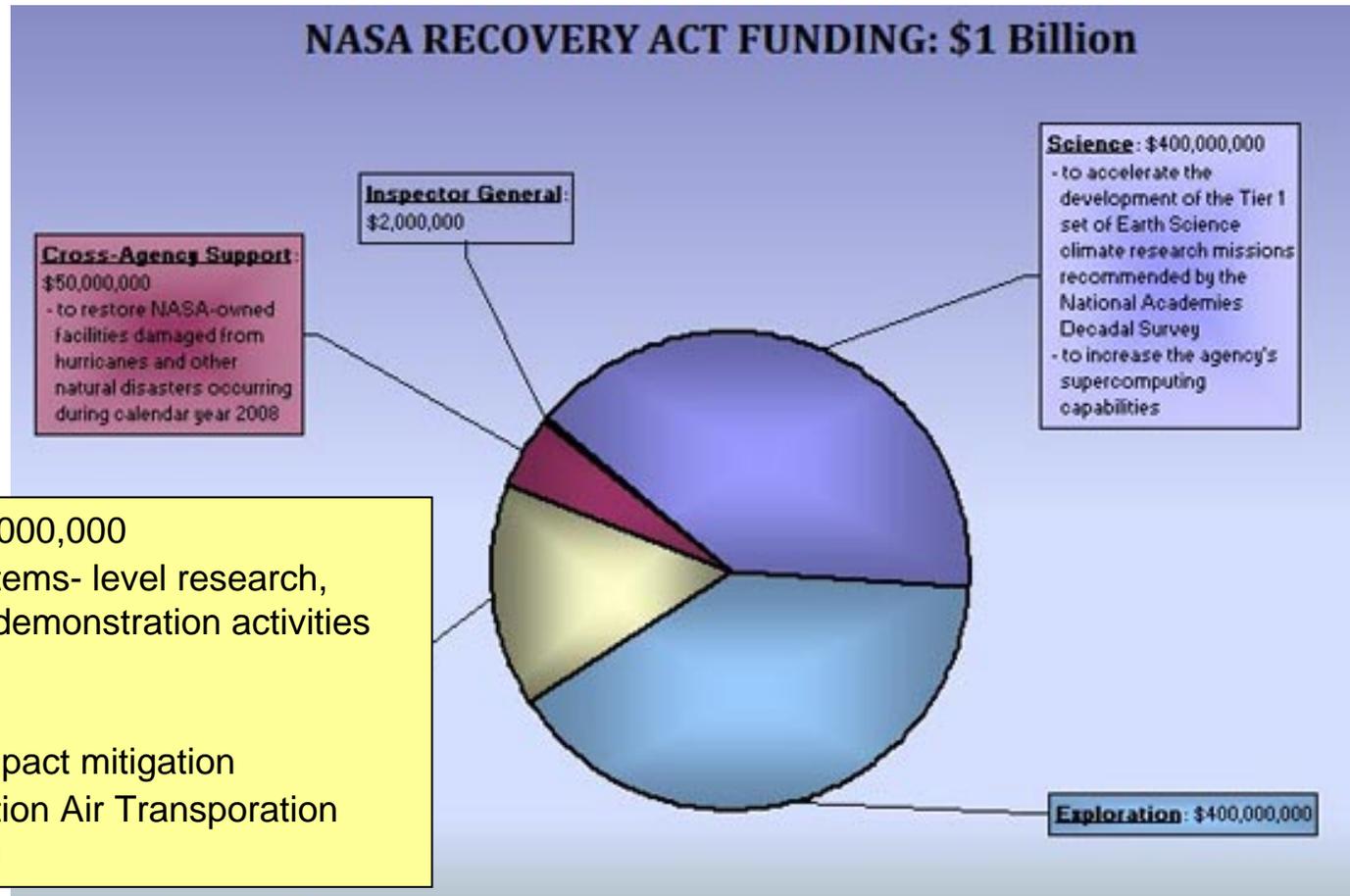
Gen. Lester Lyles (Chairman)
Dr. John Sullivan
Dr. Gene Covert
Dr. Ilan Kroo
Dr. Ray Colladay (ex-officio)

April 16, 2009

Areas of Interest Explored at Current Meeting

- Dr. Jaiwon Shin, Associate Administrator for Aeronautics Research Mission Directorate (ARMD), NASA
 - Status of NASA's System-level research in Environmentally Responsible Aviation (ERA)
 - Aeronautics Test Facility Business Base
 - NASA/Air Force Executive Research Committee
- Jean Wolfe, Strategic Integration Manager, ARMD, NASA
 - Status of NRC Meeting of Experts on NASA Plans for Environmentally Responsible Aviation (ERA)
- J.D. Kundu, NASA Aeronautics Program Examiner, Office of Management and Budget
 - Input from OMB on NASA's Aeronautics Budget and Administration Changes in Direction
- Dr. Amy Pritchett, Director for the Aviation Safety Program, ARMD, NASA
 - NRC Study of NASA's Aviation Safety Research
 - V&V of Complex Systems
- Dr. Mike Ryschkewitsch, Chief Engineer, NASA
 - NASA Investments in EDL Capabilities and Technologies

NASA Recover Act Funding – Aeronautics



Committee Recommendations

(Feb 2008) Systems-level research projects with discrete start and end dates should be considered in addition to and as an augmentation of the existing funded effort.

(Feb 2009) Convene a small, 2 step workshop under the NAC Aeronautics Committee to provide external community input to NASA's formulation of the system-level program on Environmentally-Responsible Aviation.



NASA Response to 2008 NAC Recommendation – Vision for NASA Aeronautics

Potential Candidates



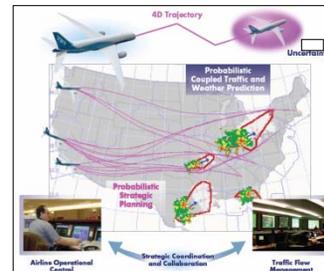
Environmentally Responsible Aviation



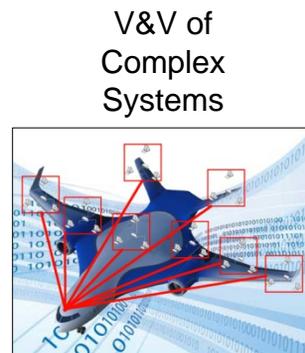
Supersonic Testbed



UAS routine access to NAS



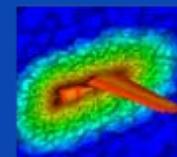
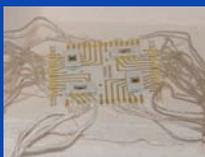
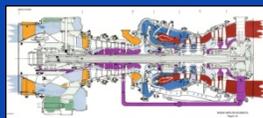
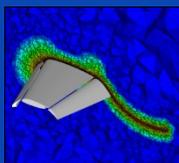
High-Fidelity NAS Simulation



V&V of Complex Systems

System-level Research to validate feasibility of Game Changers

Fundamental Research





NASA Plans for System Level Research

Environmentally Responsible Aviation

- Vehicle Theme
 - **Explore/demonstrate the feasibility, benefits, and risks of vehicle concepts and enabling technologies identified to have potential to mitigate the impact of aviation on the environment**
- Operations Theme
 - **Research system level integration of key concepts which integrate surface, super-density, separation assurance and/or traffic flow management elements**

Transfer knowledge outward to the aeronautics community, and inward to NASA fundamental aeronautics projects



Fixed Wing System Level Metrics

...technology for improving noise, emissions, & performance

CORNERS OF THE TRADE SPACE	N+1 (2015) ^{***} Generation Conventional Tube and Wing	N+2 (2020) ^{***} Generation Unconventional Architecture	N+3 (2025) ^{***} Generation Advanced Aircraft Concepts
Noise	-32 d B (cum below Stage 4)	-42 d B (cum below Stage 4)	55 LDN (dB) avg airport boundary
LTO NOx Emissions (below CAEP 6)	-60%	-75%	better than -75%
Performance: Aircraft Fuel Burn	-33% ^{**}	-40% ^{**}	better than -70%
Performance: Field Length	-33%	-50%	exploit metro-plex* concepts

^{***} Technology readiness level for key technologies = 4-6

^{**} Additional gains may be possible through operational improvements

^{*} Concepts that enable optimal use of runways at multiple airports within the metropolitan area

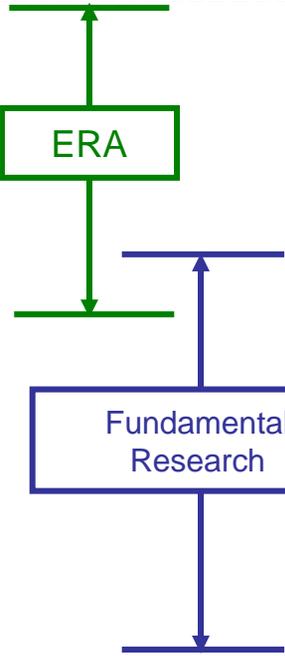
ERA-Vehicle Theme - planning activity framework

- N+2 Generation focus selected
- Simultaneous achievement of goals
- Vehicle Concepts to simultaneously reduce noise/emissions/fuel burn
- Improved propulsive and core efficiency and reduced NOx/noise



Technology Maturation Perspective for ERA

<u>TRL</u>	<u>NASA Definition (NPR 7120.8)</u>
9	Actual system flight proven through successful mission operations
8	Actual system completed and “flight qualified” through test and demonstration
7	System prototype demonstrated in operational environment
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6	System/sub-system model or prototype demonstration in relevant environment
5	Component and/or breadboard validation in relevant environment
4	Component and/or breadboard test in laboratory environment
3	Analytical and experimental critical function, and/or characteristic proof-of-concept
2	Technology concept and/or application formulated
1	Basic principles observed and reported

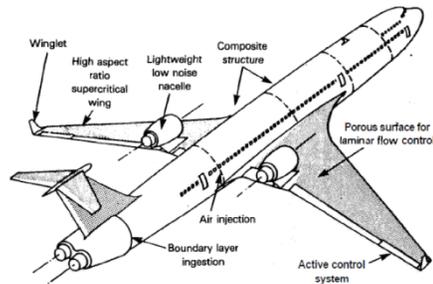


Alternate Configuration Concepts

Many ideas, but...

What combination of configuration and technology can meet the goals?

What is possible in the N+2 timeframe?



Example Experiments using NextGen Testbeds

DFW is 3rd busiest US tower (movements) per FAA 2007

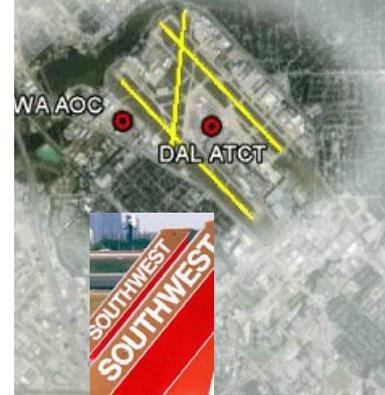
- NextGen requires tests of multiple, integrated concept capabilities such as:
 - Linking surface, arrival and departure flows
 - Interaction of flow management with separation assurance

DAL is 50th busiest US tower (movements) per FAA 2007

- North Texas Facility (NTX) embeds NASA research assets in an interesting metroplex operational environment
 - Concept definition activities support experiments
 - System analyses enable consideration of future aircraft fleets and operations



AA AOC



NASA Response to 2009 NAC Recommendation



Title: NRC Meeting of Experts on NASA Plans for System-level Research in Environmentally Responsible Aviation (ERA)

Date: May 14-15, 2009

Location: Gaylord National Hotel and Convention Center, National Harbor, MD

Expected Attendance: 25 Subject Matter Experts, 5 NRC Staff, 25 NASA Presenters/Participants, 25 General Public Participants

Safety-Related Research in NASA's Aeronautics Research Mission Directorate



Amy Pritchett, Director
NASA Aviation Safety Program



Study Charter

- NASA Authorization Bill included:
SEC. 305. EXTERNAL REVIEW OF NASA'S AVIATION SAFETY-RELATED RESEARCH PROGRAMS.
(a) Review.—The Administrator shall enter into an arrangement with the National Research Council for an independent review of NASA's ***aviation safety-related research programs.***



Status

- Pre-press copy of report due to NASA ~Feb 15, 2010
- 3 Meetings in budget
- 1st meeting dates being proposed (June 22nd or 23rd?)
- Committee being finalized, not yet announced

Verification & Validation of Flight-Critical Systems—Overview and Status



Status:

- Core planning team in place

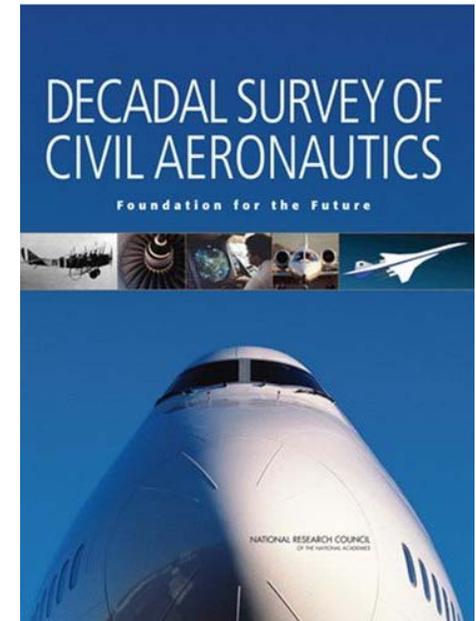
Amy Pritchett, Director
NASA Aviation Safety Program

April 15, 2009

Widely Recognized Concern

Recommendation 4: Fundamental research is needed to create the foundations for practical certification standards for new technologies

- methods and models are needed for assessing the safety and reliability of complex, large-scale, human-interactive, nondeterministic software intensive systems



For Certification Flight Safety Level A

- ~1 million lines of code
- \$1-2 Billion



NASA Investments in Entry Descent and Landing (EDL) Capabilities and Technology [Where Aeronautics and Space Converge]

Briefing to the Aeronautics/Science/Exploration Committees
of the
NASA Advisory Counsel

NASA HQ
15 April 2009

Dr. Michael Ryschkewitsch, NASA Chief Engineer
Mr. Walt Engelund – NASA Langley Research Center
Mr. Henry Wright – NASA Langley Research Center

NAC Feb 3, 2009



Manned Mission to Mars

“You can’t get there from here!”



EDL is an Agency Level Challenge ...

No one Mission Directorate owns the “EDL Problem” or can solve it by themselves...

- **The fundamental physics that define Entry, Decent, and Landing on a planetary body with an appreciable atmosphere are rooted in the aeronautics and aerosciences disciplines. But Aeronautics Research Mission Directorate provides no “mission pull”**
- **The robotic missions (Science Mission Directorate) that rely on EDL technologies to get to the surface of a planet in the presence of an atmosphere are really about conducting science, not the technology to get there. But they define the technology and mission requirements, and should be good stewards of the technology capabilities**
- **Eventual human Mars mission (Exploration Systems Mission Directorate) will ultimately require new EDL technology architectures for human scale infrastructure, but can not be done in a vacuum. They will leverage and rely on investments and capabilities developed and demonstrated by their counterparts in ARMD and SMD (and in fact are doing so right now)**
- **The reality is that it is an Agency issue requiring the attention of all three MD’s (and the question becomes that of coordination)**



Summary Comments

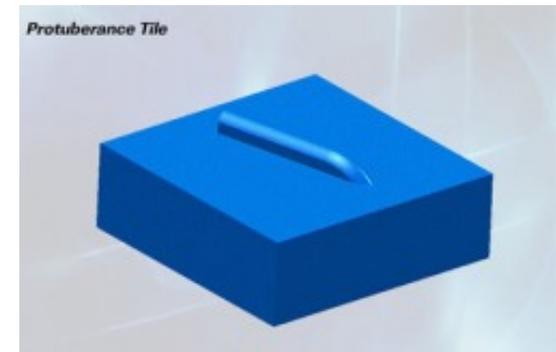
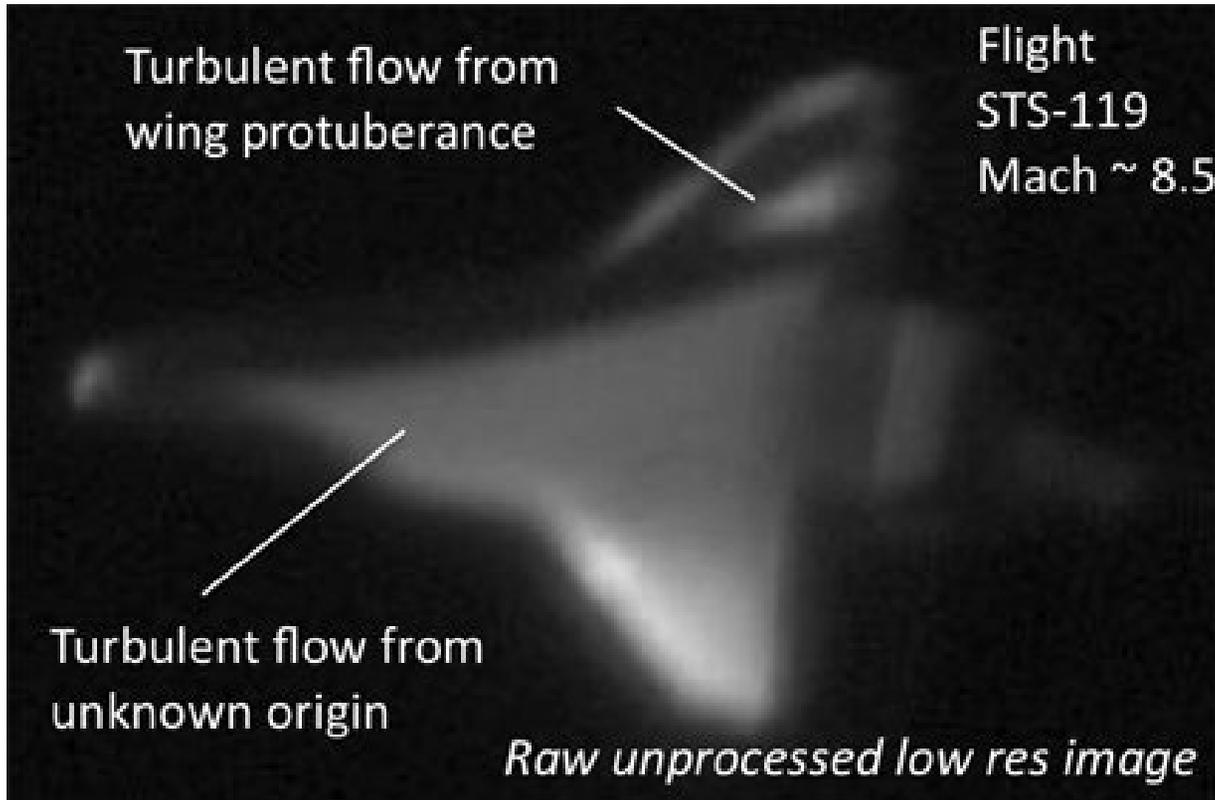
- **Entry, Descent, and Landing elements provide the “cornerstone” in any planetary atmospheric flight mission architecture design**
- **The current Mars EDL toolbox was developed by the Viking program in the 1970s and does not appear extensible to the large landed mass requirements for future robotic and human Mars missions**
- **Need to develop an understanding of requirements for future robotic and large scale human mission sets, and develop EDL technologies that would serve both**
- **Leverage future robotic mission EDL technology development as a proving ground for future large scale land mass capabilities**
- **Utilize the Agency’s multi center EDL team to lead a multi-year EDL technologies Systems Analysis Project to help the Agency become a “Smart Buyer” for future EDL technology investments enabling large scale Mars missions**



Take Home Messages...

- **Mars EDL on a scale larger than we previously have demonstrated is an Agency issue requiring the attention of all three MD's**
- **Enabling human scale missions to Mars requires extensive EDL architecture and technology development efforts, with a 25 year mission horizon if we start now**
- **NASA needs a coordinated sustained investment for advanced EDL and atmospheric flight system technologies to reduce mission risk and to enable future robotic and human class missions**

Experiment Performed on Shuttle Heat Tiles During Discovery's Re-Entry



A Navy P-3 Orion aircraft flying over the Gulf of Mexico captured infrared images

Plans for Next Meeting

- Briefing on NASA ARMD Updated Plans for System-level Research in Environmentally Responsible Aviation (ERA) and Results of NRC Meeting of Experts
- Briefing from the FAA on environmental efforts and connectivity to ERA
- Briefing from the ARMD Aeronautics Test Program on its newly developed strategic plan