National Aeronautics and Space Administration

Aeronautics Research Mission Directorate Update with emphasis on Integrated Systems Research

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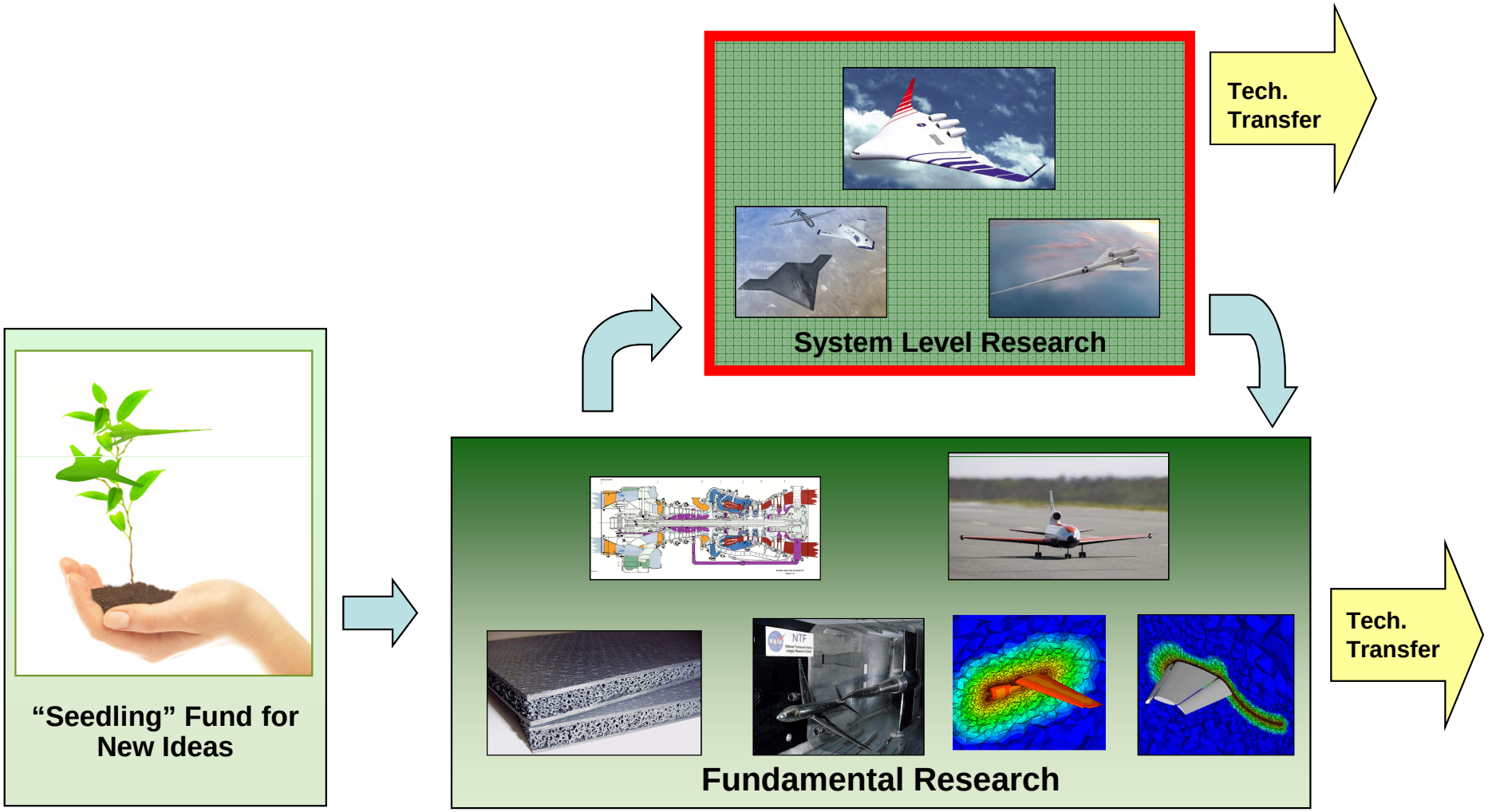
NASA Aeronautics Investment Strategy



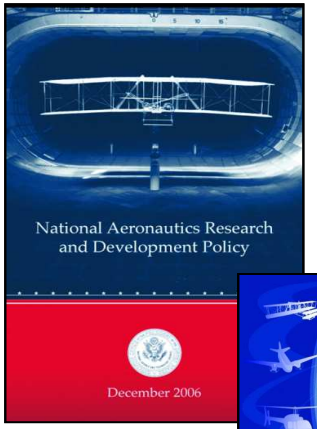
Enabling "Game Changing" concepts and technologies from advancing fundamental research ultimately to understand the feasibility of advanced systems

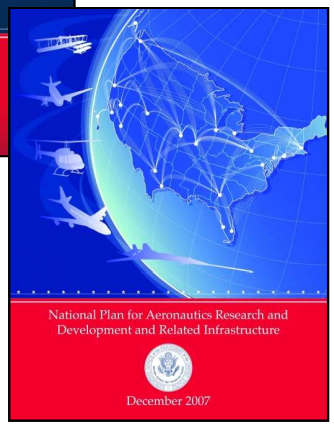
“Why” Integrated Systems Research?

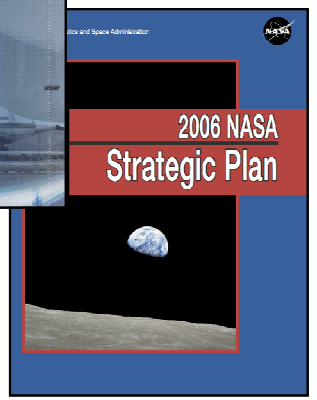
- **ARMD’s own assessment**
  - **Stable funding and consistent fundamental research direction are producing promising concepts, capabilities, and technologies that can be further developed, explored, and assessed at system level in a relevant environment**
- **The NASA Advisory Council (NAC)**
  - **Strongly supports ARMD’s fundamental research program.**
  - **However, the NAC members also have called for ARMD to plan and develop candidate systems-level research projects, consistent with the National Policy and Plan and leveraging NASA’s unique expertise and competencies, to advance the state-of-the-art capabilities in key disciplines and facilitate transition of results to the community.**
- **Industry**
  - **Strong support for both existing “base” program and new system research plans**
- **Congress**
  - **FY08 Congressional Augmentation - Invest in Next Generation Air Transportation System (NextGen) ; “Green” aircraft research that will yield advanced technologies to significantly reduce energy consumption, emissions, and noise; Research aligned with the top-ranked priorities in the National Academies’ Decadal Survey of Civil Aeronautics**
  - **American Recovery Act - System-level research, development and demonstration activities related to aviation safety, environmental impact mitigation and the NextGen**
  - **FY09 Congressional Augmentation – investments across all programs**

The National and NASA Contexts

- National Aeronautics R&D Policy (Dec 2006) and Plan (Dec 2007)
  - "Mobility through the air is vital…"
  - "Aviation is vital to national security and homeland defense"
  - "Assuring energy availability and efficiency …" and "The environment must be protected…"
- NextGen: The Next Generation Air Transportation System
  - Joint Planning Development Office (JPDO), Vision 100 (2003)
  - Revolutionary transformation of the airspace, the vehicles that fly in it, and their operations, safety, and environmental impact
- NASA Strategic Plan
  - Sub-Goal 3E: "Advance knowledge in the fundamental disciplines of aeronautics, and develop technologies for safer aircraft and higher capacity airspace systems."







NASA Aeronautics Portfolio in FY2010



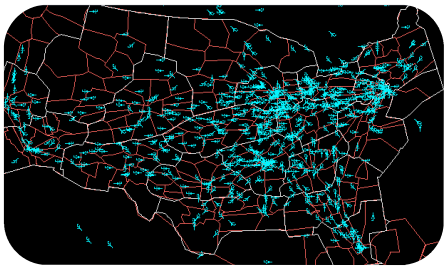
Fundamental Aeronautics Program

Conduct cutting-edge research that will produce innovative concepts, tools, and technologies to enable revolutionary changes for vehicles that fly in all speed regimes.

Integrated Systems Research Program

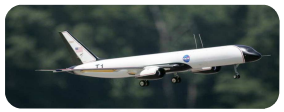
Conduct research at an integrated system-level on promising concepts and technologies and explore/assess/demonstrate the benefits in a relevant environment





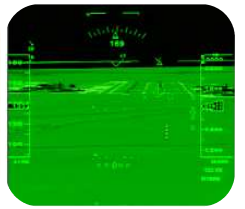
Airspace Systems Program

Directly address the fundamental ATM research needs for NextGen by developing revolutionary concepts, capabilities, and technologies that will enable significant increases in the capacity, efficiency and flexibility of the NAS.

Aviation Safety Program

Conduct cutting-edge research that will produce innovative concepts, tools, and technologies to improve the intrinsic safety attributes of current and future aircraft.


Aeronautics Test Program

Preserve and promote the testing capabilities of one of the United States' largest, most versatile and comprehensive set of flight and ground-based research facilities.

Why Green Aviation? – National Challenges

Fuel Efficiency

- In 2008, U.S. major commercial carriers burned 19.6B gallons of jet fuel. DoD burned 4.6B gallons
- At an average price of $3.00/gallon, fuel cost was $73B

Emissions

- 40 of the top 50 U.S. airports are in non-attainment areas that do not meet EPA local air quality standards for particulate matter and ozone
- The fuel consumed by U.S. commercial carriers and DoD releases more than 250 million tons of CO_2 into the atmosphere each year

Noise

- Aircraft noise continues to be regarded as the most significant hindrance to NAS capacity growth.
- FAA's attempt to reconfigure New York airspace resulted in 14 lawsuits.
- Since 1980 FAA has invested over $5B in airport noise reduction programs

Significant Reduction in Environmental Impact of Aviation is Possible

Operations Estimated Fuel Savings

Continuous climbs and descents (data from top-27 airports):

- **188M gal/year reduction in fuel burn with direct climbs**
- **218M gal/year reduction in fuel burn with continuous descents**

Direct routing/improved re-routing/collaborative Traffic Flow Mgmt

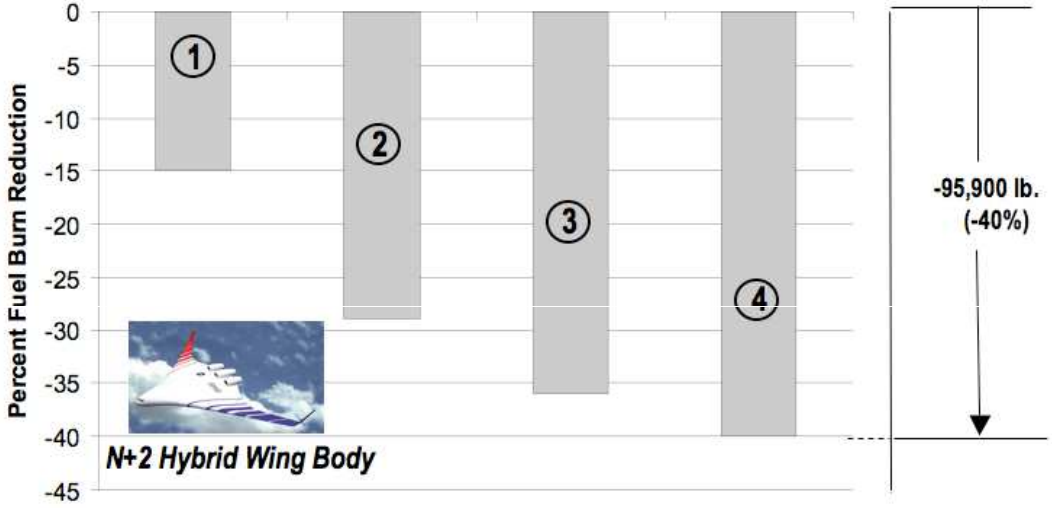
- **200M gal/year fuel savings**

"No-stop" taxi operations (data on arrivals only at 35 OEP airports):

- **15M gal/year reduction in fuel burn**
- **1M kg/year reduction in harmful emissions (CO, HC, NOx, SOx)**

Vehicle Estimated Fuel Savings*

Achieving Significantly Reduced Fuel Burn Will Require Integration of Multiple Technologies



1 = Hybrid wing configuration
2 = + advanced engine and airframe technologies
3 = + embedded engines with BLI inlets
4 = + laminar flow

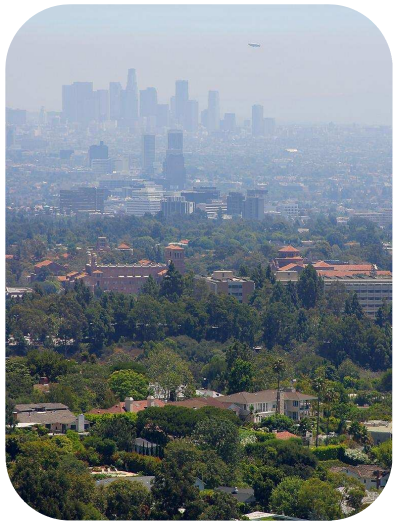
*** NASA systems analysis results.**
Reductions relative to B777 with GE90 engines.

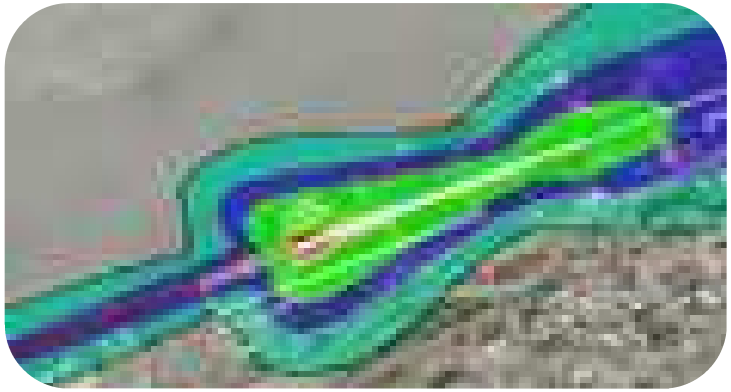
Environmentally Responsible Aviation (ERA) Project

Environmentally Responsible Aviation (ERA) Project Goal

Technology development project, that will explore and assess new vehicle concepts and enabling technologies through system-level experimentation to *simultaneously* reduce fuel burn, noise, and emissions

- *Airframe Technology*
- *Propulsion Technology*
- *Vehicle Systems Integration*

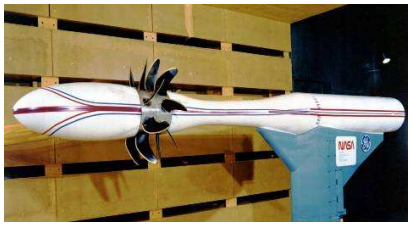




Green Aircraft

X-48B

Open Rotor Propulsor



Geared Turbofan

NASA's revolutionary enabling technology

- Novel architectures for increased L/D
- Light weight structures
- Laminar flow to reduce drag

- Low NOx combustors
- Open rotors
- Alternative fuels

- Ultra-high bypass turbofans
- Airframe noise shielding using novel aircraft architectures

Benefits to the Public

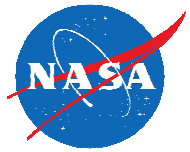
Fuel burn savings:
Over 40% reduction from current aircraft

Emissions reduction:
Local air quality:
75% less NOx (CAEP 6)
Global climate:
40% less CO_2 (B777,GE90)

Noise reduction
1/6th the objectionable ground noise footprint of current aircraft

Over 73 flights since July 2007 of the Hybrid Wing Body X-48B aircraft, in partnership with the U.S. Air Force, Boeing, and Cranfield Aerospace Ltd.

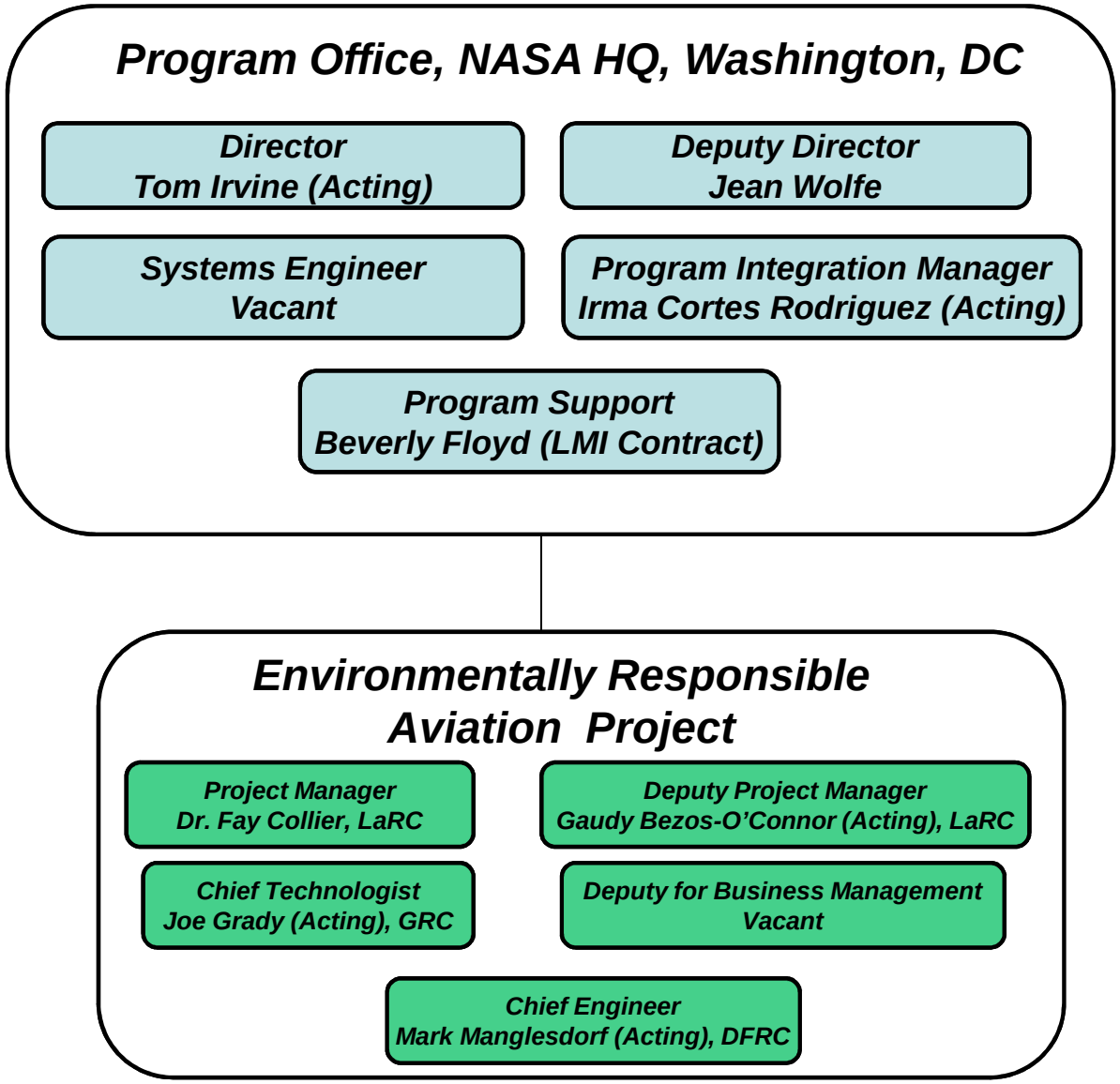
Other Similar Agency Efforts in Green Aircraft



The ERA Project complements other government research programs

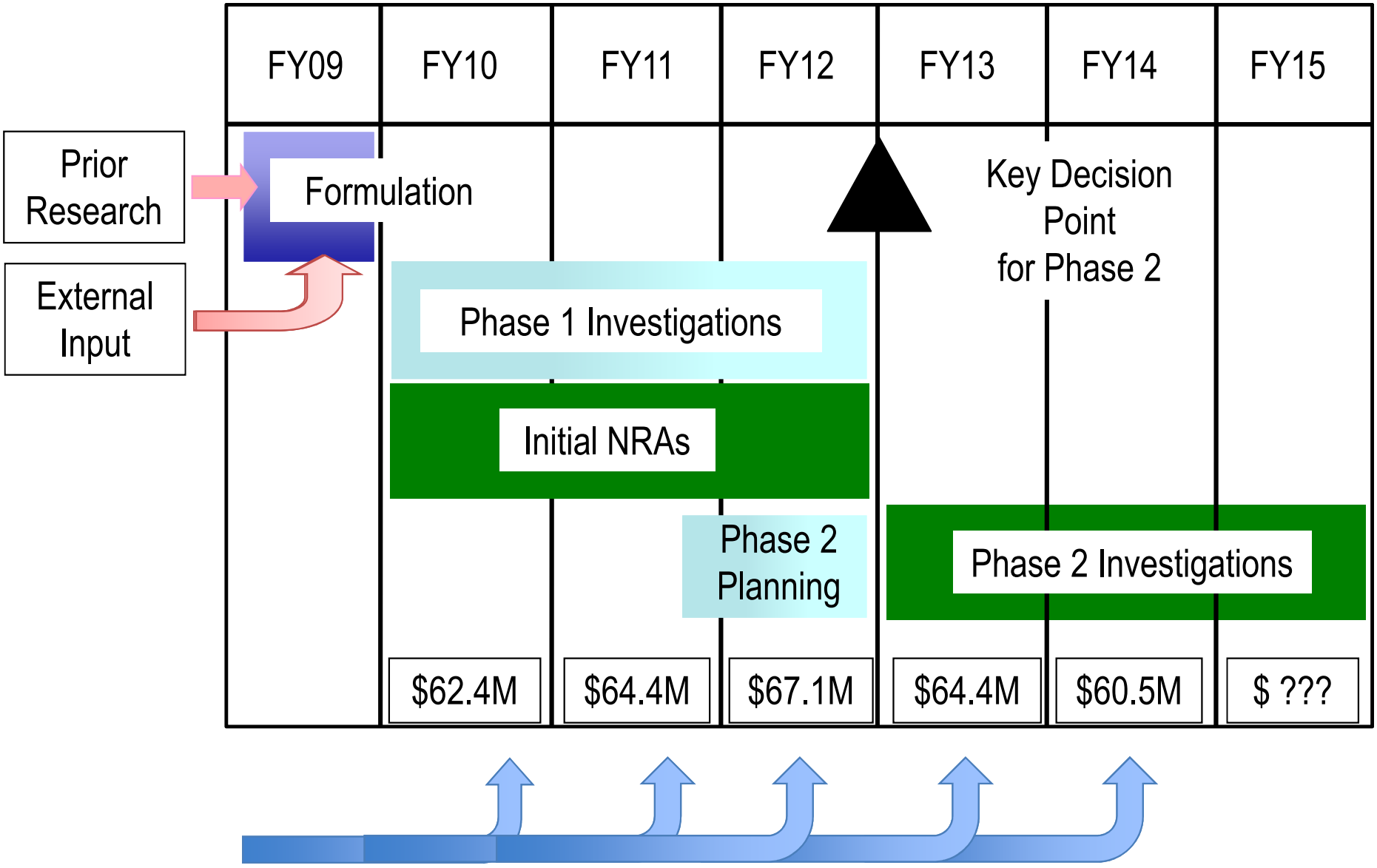
Agency	Project or Activity	Funded Years	Vehicle Focus	Proposed TRL	Goal: Major Reduction/ *Minor Reduction*
FAA	CLEEN	FY10-FY14	N+1	6-7	Noise Emissions Fuel burn
DoD	ADVENT/ HEETE/ AD-HEETE	FY10-FY14	N+2	>6	Fuel burn *Noise* *Emissions*
NASA	ERA	FY10-FY14	N+2	4-6	Simultaneous Noise Emissions Fuel Burn
NASA	SFW & SUP	FY10-FY14	N+3	2-4	Noise Emissions Fuel Burn
DoD	RCEE	FY10-FY14	N+3	2-4	Fuel Burn *Emissions* *Noise*

Integrated Systems Research Program Team



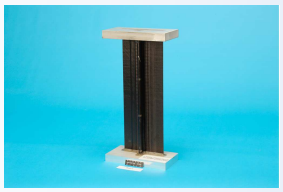
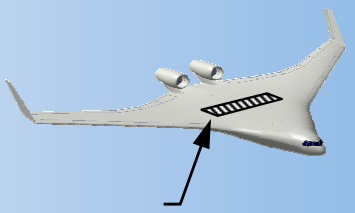
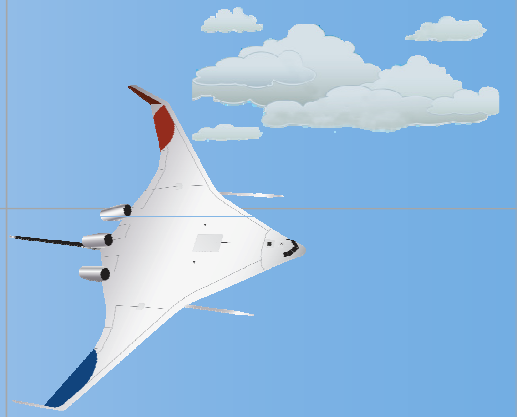
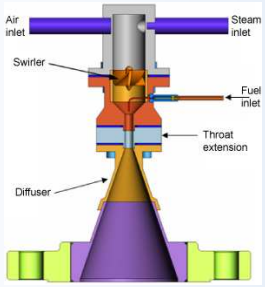
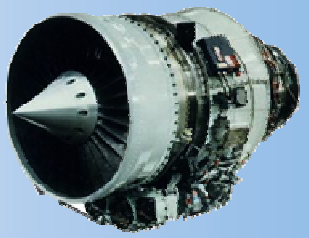
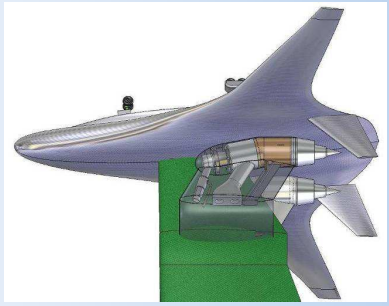
LaRC - NASA Langley
GRC - NASA Glenn
ARC - NASA Ames
DFRC - NASA Dryden

ERA Project Flow
And Key Decision Point for Phase 2

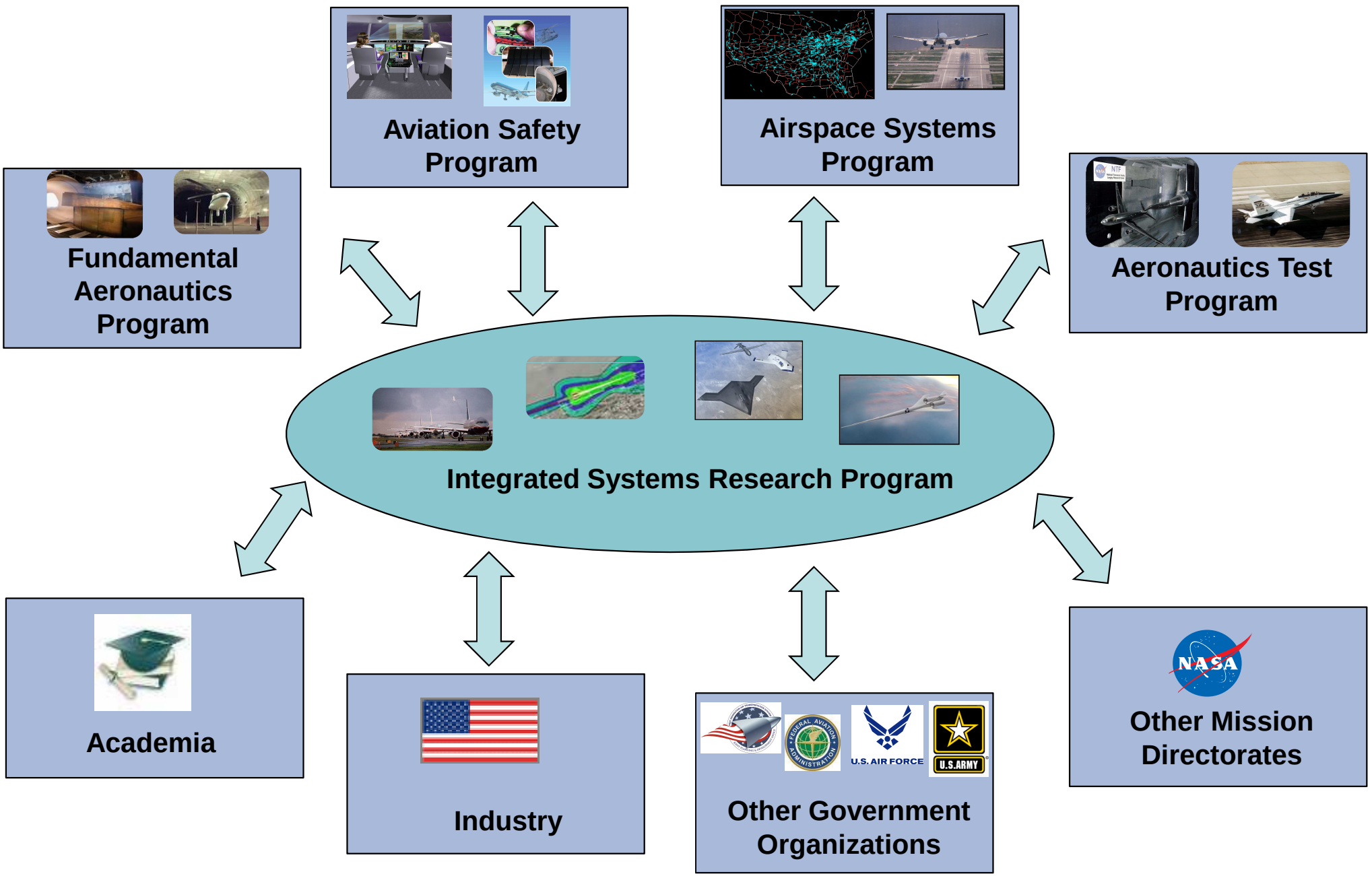


Technical input from Fundamental Programs, NRAs, Industry, Academia, Other Gov't Agencies

Integrated Systems Research Program (ISRP)-
Environmentally Responsible Aviation (ERA) Project

	Fundamental Aeronautics		Integrated Systems Research	
	Components	**Sub System**	**System**	**Testbed A/C**
Airframe Lightweight Structures Flight Dynamics and Control Drag Reduction Noise Reduction				**Demonstrated fuel burn savings:** Over 40% reduction 
Propulsion Combustor Technology Propulsor Technology Core Technology				 **Emissions reduction:** Local air quality: 50% less NO_x Global climate: 40% less CO_2
Integration Systems Analysis Propulsion Airframe Integration Propulsion Airframe Aeroacoustics Advanced Vehicle Concepts				 **Noise reduction:** 1/6th the objectionable

Collaboration and Partnerships



Current Status and Future Plans for ISRP and the ERA Project

- Began Program and Project Implementation on October 1, 2009, however, initial efforts were limited due to a Continuing Resolution until December 18, 2009

- Plan to interact with Industry and Other Government Agencies to strengthen existing partnerships inherited from SFW Project and form new partnerships for ERA

- Continued Roll-out of detailed technical plans at future aerospace meetings and conferences

- Annual Technical Meeting and Presentation of Accomplishments in November 2010