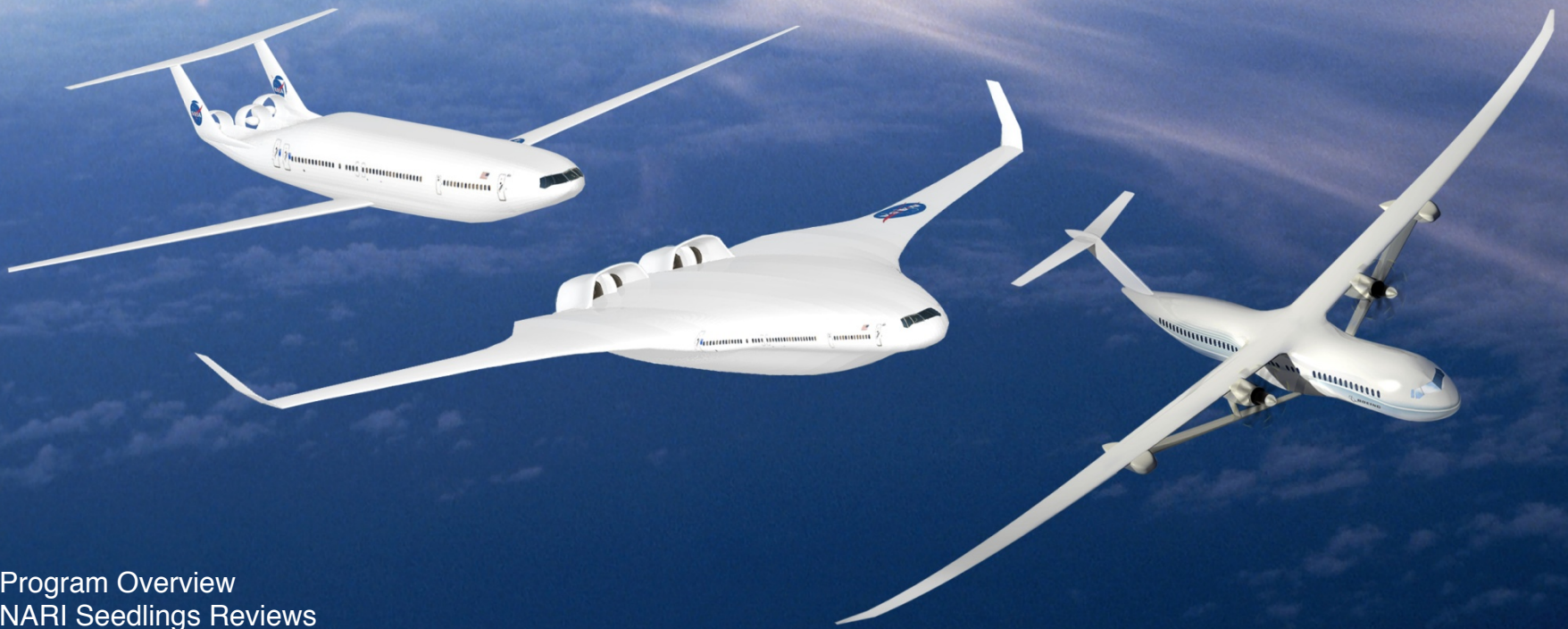
National Aeronautics and Space Administration

NARI Seedling Reviews: Propulsion

Dr. Rubén Del Rosario, P.E.

Manager, Fixed Wing Project
NASA Fundamental Aeronautics Program



Program Overview
NARI Seedlings Reviews
February 27, 2014

NASA Aeronautics Programs

and where the Green Aviation emphasis is



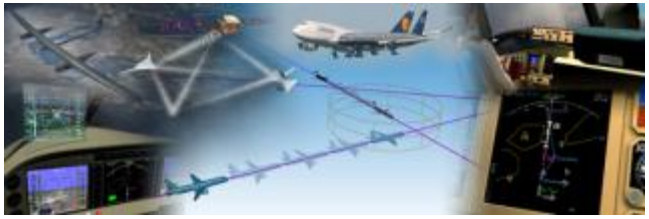

Fundamental Aeronautics Program

Conduct fundamental 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



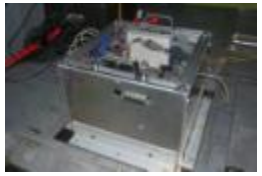


Airspace Systems Program

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

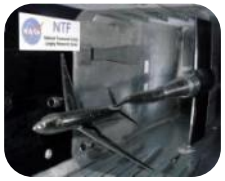
Conduct cutting-edge research that will produce innovative concepts, tools, and technologies to improve the intrinsic safety attributes of current and future aircraft.





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.




High Speed Project Overarching Goal

Develop and Validate Tools, Technologies and Concepts to Overcome the Barriers to Practical High Speed Vehicles

Project Focus FY 13-17

Development of tools and integrated concepts that will enable demonstration of overland supersonic flight with acceptable sonic boom

Scope

- Civil Supersonic Aircraft: business class to supersonic airliners
- Partnership with the DoD for development and validation of scramjet propulsion system

Overcoming the Barriers to Practical High Speed Vehicles

Environmental Barriers

Sonic Boom

- Design for low noise sonic boom
- Understand Community Response

Airport Noise

- Noise levels not louder than subsonic aircraft at appropriate airports

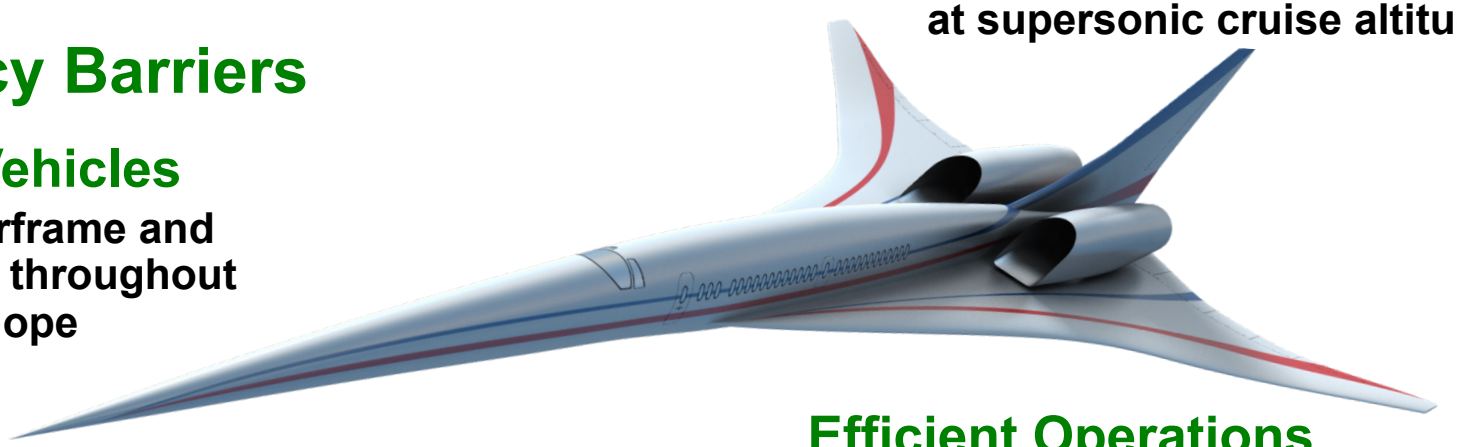
High Altitude Emissions

- No or minimal long term impact at supersonic cruise altitudes

Efficiency Barriers

Efficient Vehicles

- Efficient airframe and propulsion throughout flight envelope



Light Weight, Durable Vehicles

- Low airframe and propulsion weight in a slender flexible vehicle operating at supersonic cruise temperatures

Efficient Operations

- Airspace-Vehicle interaction for full utilization of high speed

Solutions to Barriers Drove Selection of Research Themes

The Fixed Wing Project

Explore and Develop Technologies and Concepts for Improved Energy Efficiency and Environmental Compatibility for Fixed Wing Subsonic Transports

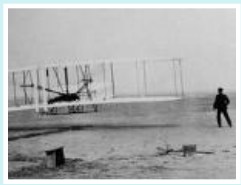
Vision

- Early-stage exploration and initial development of game-changing technology and concepts for fixed wing vehicles and propulsion systems

Scope

- Subsonic commercial transport vehicles (passengers, cargo, dual-use military)
- Technologies and concepts to improve vehicle and propulsion system energy efficiency and environmental compatibility
- Development of tools as enablers for specific technologies and concepts

Evolution of Subsonic Transports



1903 1930s 1950s 2000s

NASA Subsonic Transport System Level Metrics

v2013.1

TECHNOLOGY BENEFITS*	TECHNOLOGY GENERATIONS (Technology Readiness Level = 4-6)		
	N+1 (2015)	N+2 (2020**)	N+3 (2025)
Noise (cum margin rel. to Stage 4)	-32 dB	-42 dB	-52 dB
LTO NOx Emissions (rel. to CAEP 6)	-60%	-75%	-80%
Cruise NOx Emissions (rel. to 2005 best in class)	-55%	-70%	-80%
Aircraft Fuel/Energy Consumption‡ (rel. to 2005 best in class)	-33%	-50%	-60%

* Projected benefits once technologies are matured and implemented by industry. Benefits vary by vehicle size and mission. N+1 and N+3 values are referenced to a 737-800 with CFM56-7B engines, N+2 values are referenced to a 777-200 with GE90 engines

** ERA's time-phased approach includes advancing "long-pole" technologies to TRL 6 by 2015

‡ CO2 emission benefits dependent on life-cycle CO2e per MJ for fuel and/or energy source used

FW Research addresses revolutionary far-term goals with opportunities for near-term impact

N+3 Advanced Vehicle Concept Studies

Summary

Boeing, GE, GA Tech

NG, RR, Tufts, Sensis, Spirit

Advanced concept studies for commercial subsonic transport aircraft for 2030-35 Entry into Service (EIS)

Trends:

- Tailored/Multifunctional Structures
- High AR/Laminar/Active Structural Control
- Highly Integrated Propulsion Systems
- Ultra-high BPR (20+ with small cores)
- Alternative fuels and emerging hybrid electric concepts
- Noise reduction by component, configuration, and operations improvements

GE, Cessna, GA Tech

MIT, Aurora, P&W, Aerodyne

NASA, VA Tech, GT

NASA

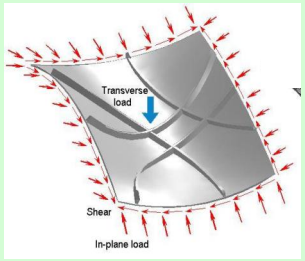
Advances required on multiple fronts…

Fixed Wing Project Research Themes

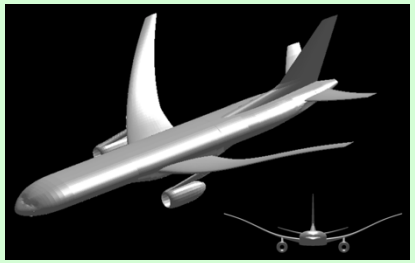
based on Goal-Driven Advanced Concept Studies

Goals Metrics (N+3)	Noise Stage 4 – 52 dB cum	Emissions (LTO) CAEP6 – 80%	Emissions (cruise) 2005 best – 80%	Energy Consumption 2005 best – 60%

Goal-Driven Advanced Concepts (N+3)

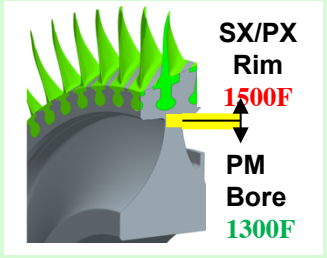


1. Lighter-Weight Lower Drag Fuselage

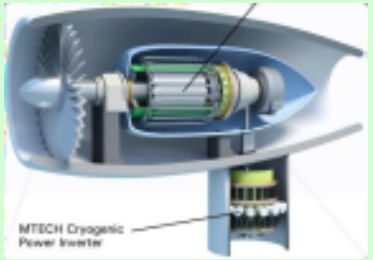


2. Higher Aspect Ratio Optimal Wing

3. Quieter Low-Speed Performance



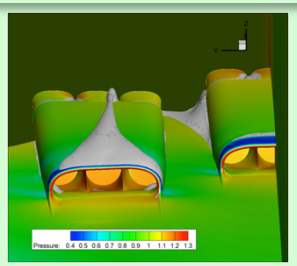
4. Cleaner, Compact Higher BPR Propulsion



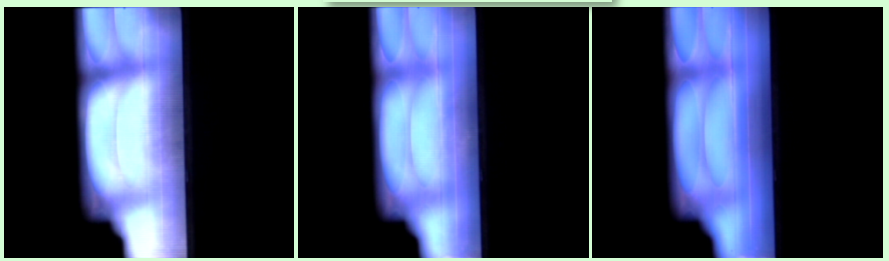
5. Hybrid Gas-Electric Propulsion

Research Themes with Investments in Both Near-Term Tech Challenges And Long-Term (2030) Vision

6. Unconventional Propulsion Airframe Integration



7. Alternative Fuel Emissions



Agenda for Today's Session

Thursday February 27, 2014					
Propulsion					
Time EST	**Time PST**	**Title**	**Presenter**	**Affiliation**	**Technical Representatives**
13:00–13:15	*10:00–10:15*	*Session Welcome and Keynote*	***Rubén Del Rosario***	**GRC**	
13:15–14:00	10:15–11:00	Liquefied Bleed	John 'Dave' Saunders	GRC	Lou Povinelli (GRC)
14:00–14:45	11:00–11:45	Holistic concepts for Aeropropulsion	Vikram Shyam	GRC	Michael Hathaway (GRC) Gary Hunter (GRC)
14:45–15:30	11:45–12:30	Real-Time Closed-Loop Modulated Turbine Cooling	Vikram Shyam	GRC	Michael Hathaway (GRC) Gary Hunter (GRC)

Back-Up