Welcome and Program Highlights

Fundamental Aeronautics Program
2008 Annual Meeting

Sheraton Atlanta

Atlanta, GA

October 7, 2008

QuickTime™ and a decompressor are needed to see this picture.

QuickTime™ and a decompressor are needed to see this picture.

Fundamental Aeronautics 2008 Annual Meeting

- 3-day meeting to communicate details of work pursued by the FA program. Interaction.
- 4 parallel technical sessions including:
  - SFW: Noise, emissions, performance for engines and airframes, tools, CESTOL, Hybrid Wing-Body
  - SRW: Propulsion, Materials & Structures, Acoustics, MDAO, Aeromechanics, ExpCap, Flight Dyn & Ctrl
  - Sup: Syst Integration, Lightweight Durable Engines & Airframes with Cruise Efficiency, Sonic Boom, High Altitude Emissions
  - Hyp: Materials & Structures, MDAO, GNC, Aerothermodynamics, Airbreathing Propulsion, EDL, Experimental Capabilities
- Student posters & student session
- 2 Plenary talks: Aircraft technologies from the operator point of view (N. Stronach, Delta Airlines) and Breaking the Sound Barrier (J. D. Anderson, Smithsonian Institution, UMD)
- Feedback sessions, one-one-one meetings
- N+3 Program Kick-Off Session
- Sonic Boom Prediction Workshop
- “Integration of Advanced Vehicles Into NextGen” Workshop (jointly with ASP, AvSP)
- For more information visit: http://www.aeronautics.nasa.gov

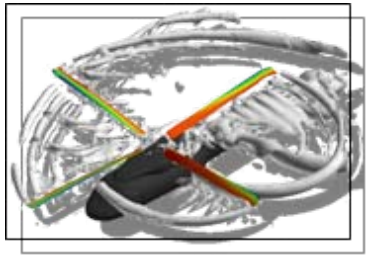
NASA Fundamental Aeronautics Program

- *Hypersonics*
  - Fundamental research in all disciplines to **enable very-high speed flight** (for airbreathing launch vehicles) and **re-entry into planetary atmospheres**
  - High-temperature materials, thermal protection systems, airbreathing propulsion, aero-thermodynamics, multi-disciplinary analysis and design, GNC, experimental capabilities

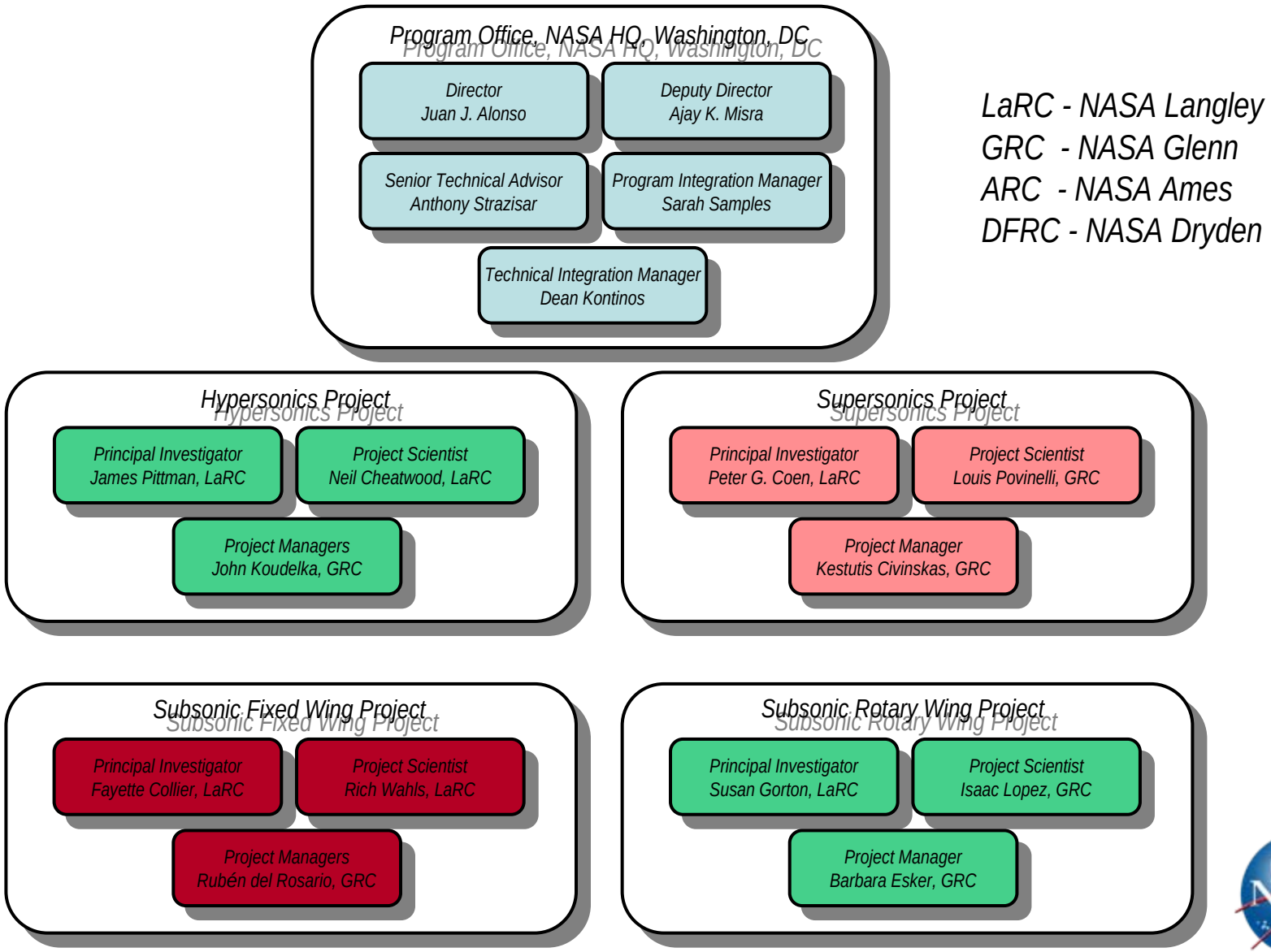
- *Supersonics*
  - **Eliminate environmental and performance barriers** that prevent **practical supersonic vehicles** (cruise efficiency, noise and emissions, vehicle integration and control)
  - Supersonic deceleration technology for **Entry, Descent, and Landing** into Mars

- *Subsonic Fixed Wing (SFW)*
  - Develop revolutionary technologies and aircraft concepts with highly **improved performance** while satisfying **strict noise and emission constraints**
  - Focus on **enabling technologies**: acoustics predictions, propulsion / combustion, system integration, high-lift concepts, lightweight and strong materials, GNC

- *Subsonic Rotary Wing (SRW)*
  - Improve **civil potential of rotary wing vehicles** (vs fixed wing) while maintaining their unique benefits
  - Key **advances** in multiple areas through **innovation** in materials, aeromechanics, flow control, propulsion

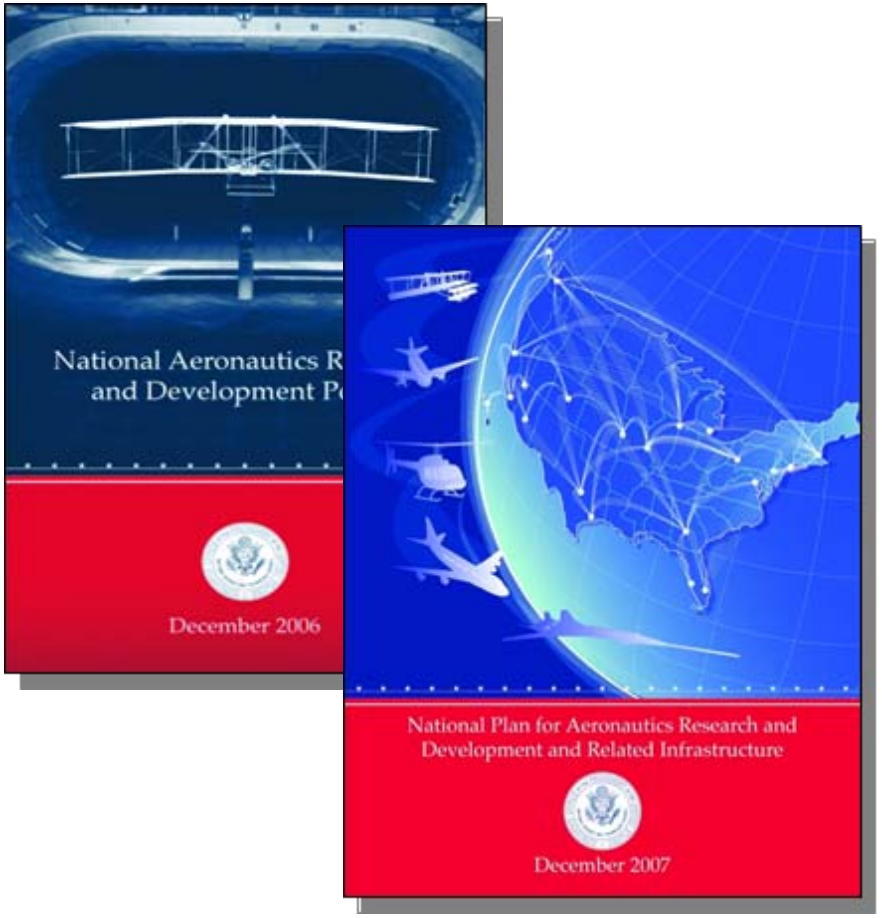


Fundamental Aeronautics Program: Organizational Chart



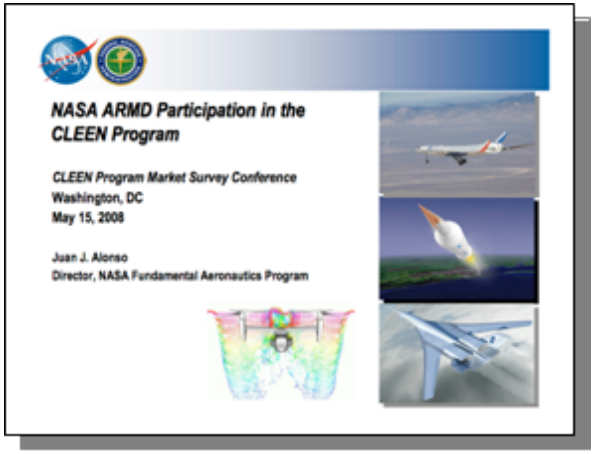
ARMD Addresses National Aeronautics R&D Policy and Plan Objectives

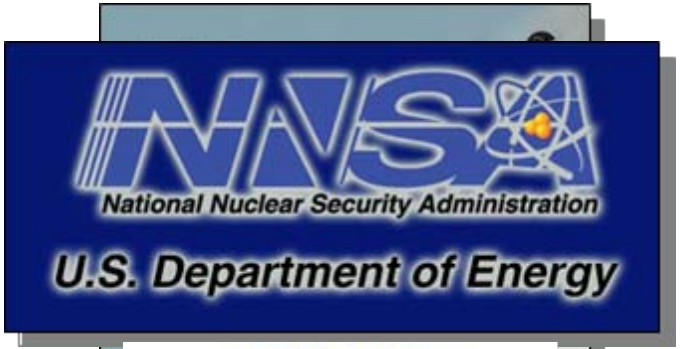
- Policy
  - Executive Order signed December 2006
  - Outlines 7 basic principles to follow in order for the U.S. to "maintain its technological leadership across the aeronautics enterprise"
  - Mobility, national security, aviation safety, security, workforce, energy & efficiency, and environment
- Plan (including Related Infrastructure)
  - Plan signed by Pres. Bush December 2007
  - Goals and Objectives for all basic principles (except Workforce, being worked under a separate doc)
  - Summary of system-level challenges in each area and the facilities needed to support related R&D
  - Specific quantitative targets where appropriate

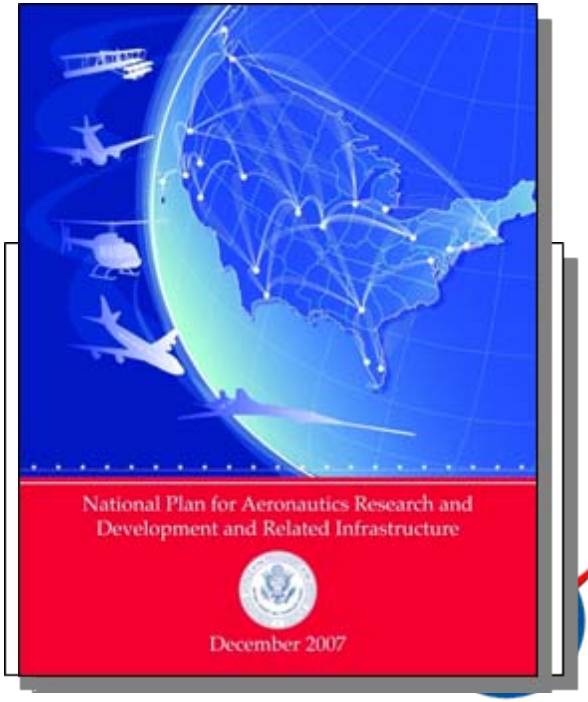


Executive Order, Policy, Plan, and Goals & Objectives all available on the web
For more information visit: http://www.ostp.gov/cs/nstc/documents_reports

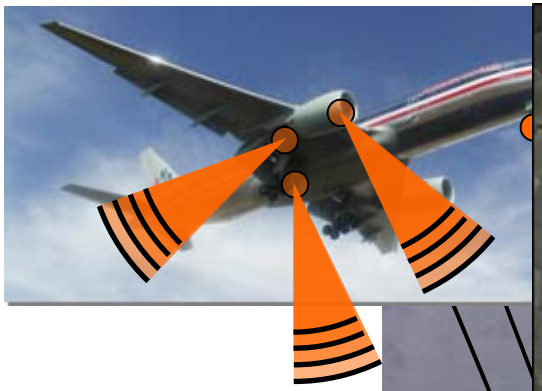
Cementing Partnerships…

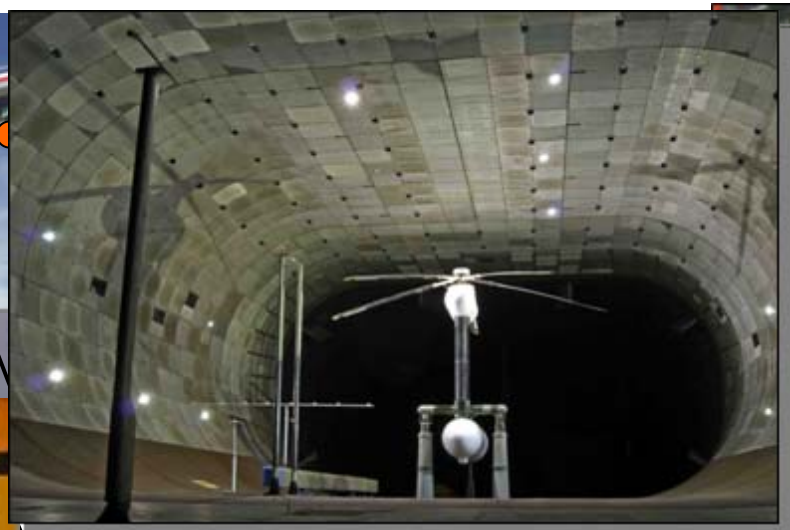


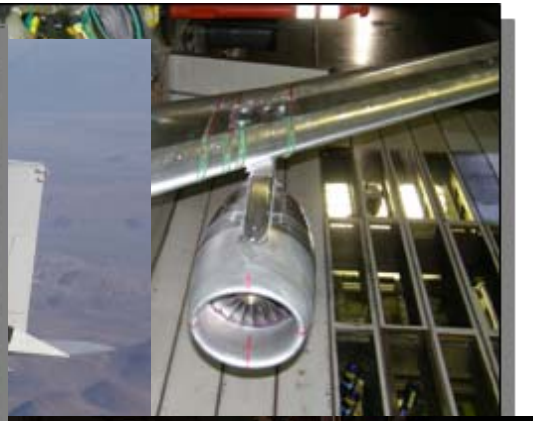




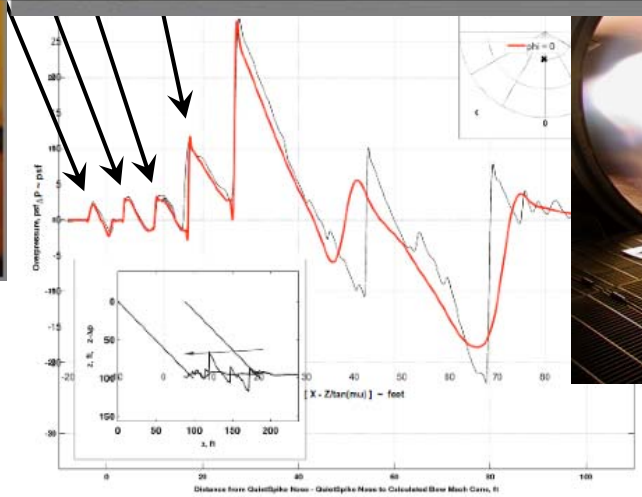
...Delivering Results

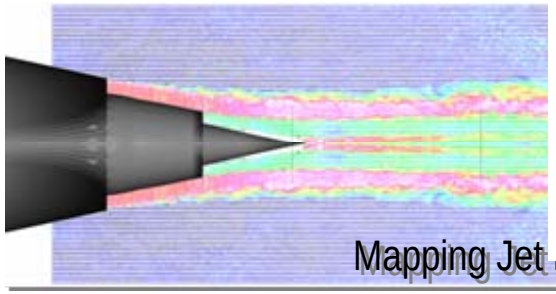






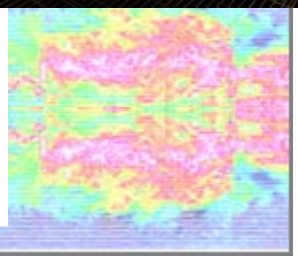
9x15 Fan Hardware





Mapping Jet Flowfield Using Particle Image Velocimetry

Preliminary CFD comparison (red) with measured signature (black) at 95 ft. below the F-15, M = 1.4, 40,000 ft



Brief Summary of Vehicle-Related Activities

QuickTime™ and a
H.264 decompressor
are needed to see this picture.

Brief Summary of High-Speed Research Activities

QuickTime™ and a
H.264 decompressor
are needed to see this picture.

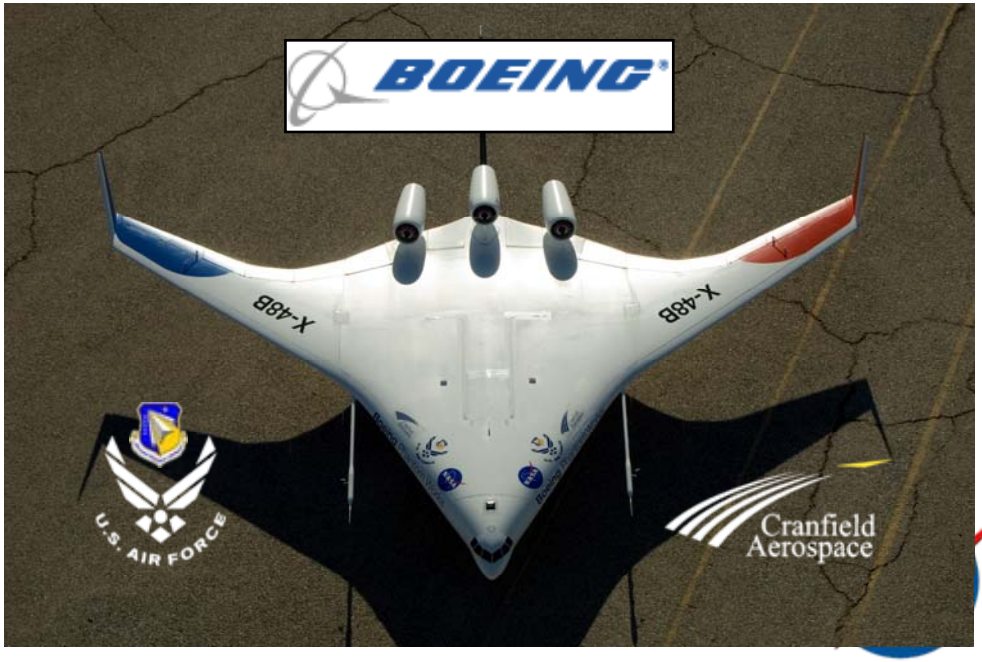
Hybrid Wing-Body Research, X-48B

First flight July 20, 2007
- X-48B
- 500 lb, 21 ft wing span
- 31 minute flight
- Low-speed flying/handling qualities experiment
- Potential future use for acoustics tests (ground and flight) and transonic experiments

23 Flights Completed (now with slats-retracted configuration)

One of Time Magazine Best Inventions of the Year 2007

QuickTime™ and a
decompressor
are needed to see this picture.



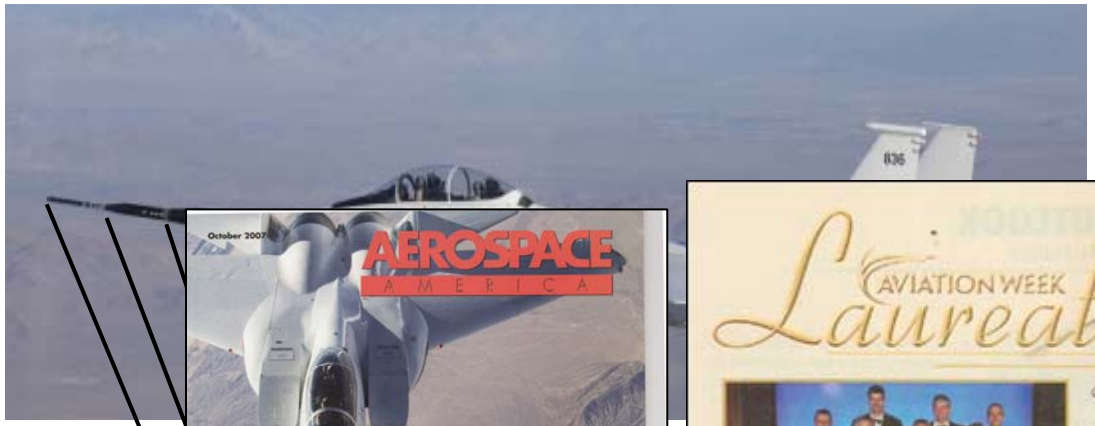
Time Magazine: Best Innovations of the Year 2007

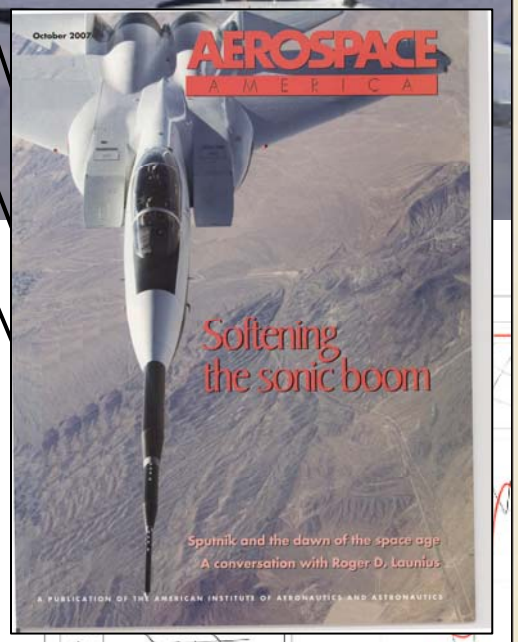
NASA/Boeing X-48B:
An aircraft revolution

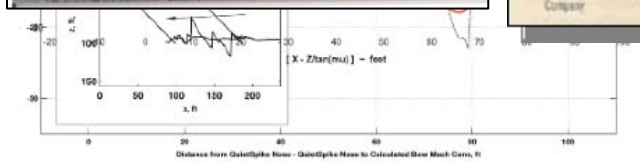
While we would have loved to have seen this cover….

We lost to the iPhone!

Quiet Spike Flight Experiment







Preliminary CFD comparison (red) with measured signature (black) at 95 ft. below the F-15, M = 1.4, 40,000 ft

- Quiet Spike™: a Gulfstream Aerospace / NASA collaboration
  - Flight validation of non-coalescing shocklets produced from Quiet Spike

lach 1.8,
structural
ock
ions

a sets,

ocess of

stream) in

leeting &
2008)

- Substantive NASA/Gulfstream collaboration opens door to future efforts

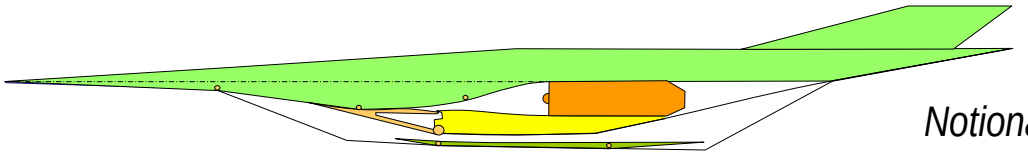
Gulfstream
A GENERAL DYNAMICS COMPANY

NASA

Subsonic Rotary Wing – Smart Rotor Test in Large Wind Tunnel

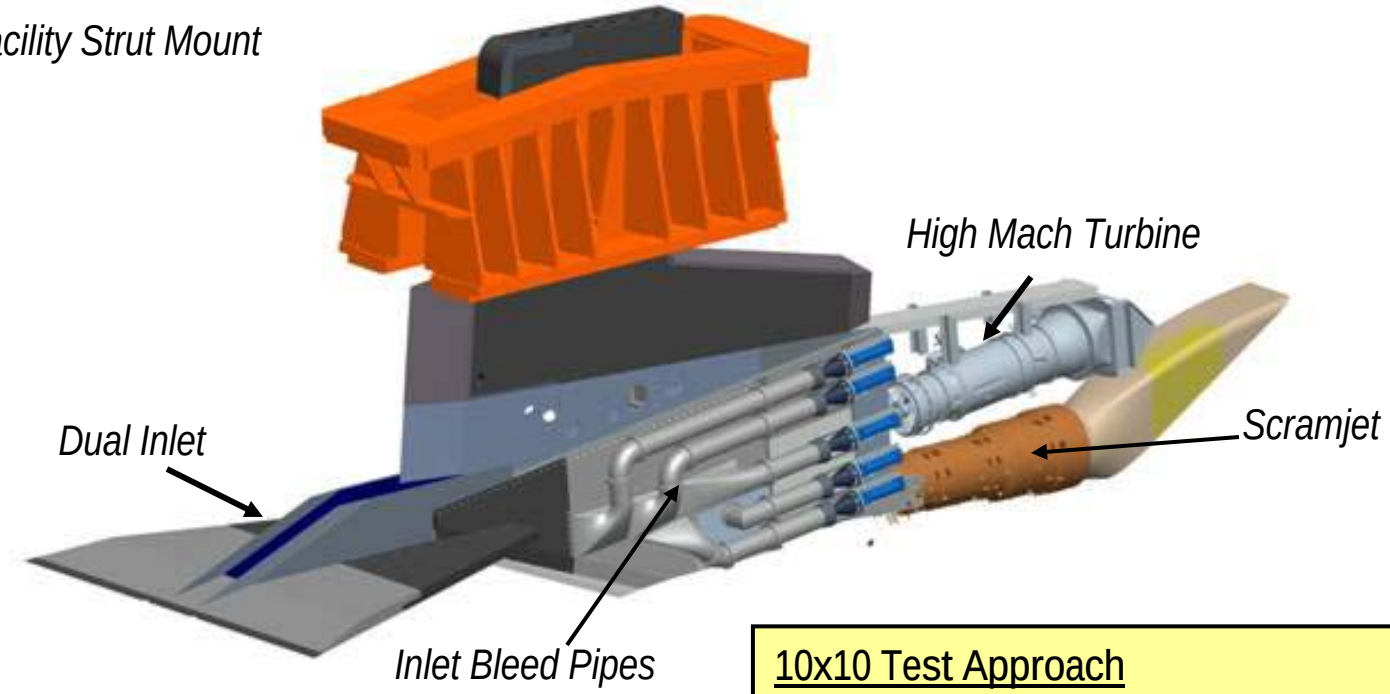
- Smart rotor incorporates cutting edge changes to MD900 baseline rotor
  - Trailing edge control flap
  - Piezo-electric “smart” material actuators
- Effectiveness of flap for noise and vibration control demonstrated
- Closed-loop feedback control applied for first time to full-scale active rotor
- Initial demonstration of blade displacement technique
- Verified analytic acoustic prediction

Turbine Based Combined Cycle (TBCC)Engine



Notional Hypersonic Vehicle With Over/under TBCC

Objective: Investigate turbine to scramjet mode transition (mach 3 range)



10x10 Test Approach

1. Inlet w/ simulated Engine backpressure
2. Demonstrate mode transition control strategies and ability to recover from inlet unstart
3. Add turbine/ nozzle for integrated system test

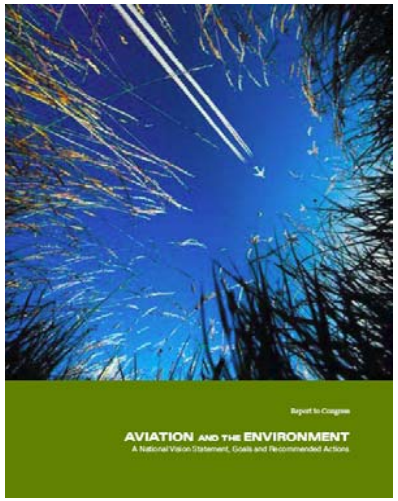
The Challenge: Next Generation Air Transportation System (NextGen)

NextGen Vision for Environment/Performance:

Provide energy efficiency and environmental protection that allows sustained aviation growth

Factors:

- 2X increase in system capacity by 2025
- Fundamental system changes
- Significant energy/fuel crisis
- Increased importance of environment
- Vision to grow aviation while reducing *significantly* its environmental impact



NASA Research Activities:

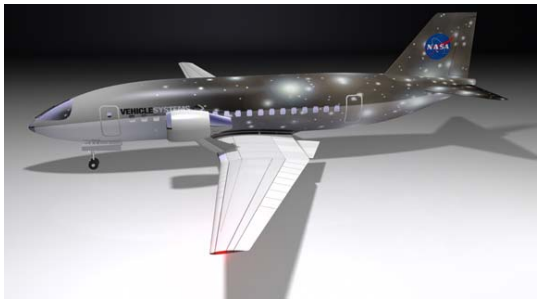
- Aggressive goals for reducing noise, emissions, and fuel burn for subsonic fixed wing, supersonic, and subsonic rotary wing vehicles
- Research the issues associated with deploying new or advanced air vehicles within NextGen
- Ensuring maintained or increased levels of safety for NextGen

SFW System Level Metrics

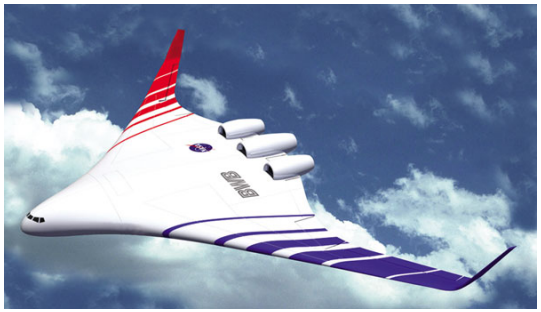
CORNERS OF THE TRADE SPACE	N+1 (2015 EIS) Generation Conventional Tube and Wing (relative to B737/CFM56)	N+2 (2020 IOC) Generation Unconventional Hybrid Wing Body (relative to B777/GE90)	N+3 (2030-2035 EIS) Generation Advanced Aircraft Concepts (relative to user defined reference)
Noise	- 32 dB (cum below Stage 4)	- 42 dB (cum below Stage 4)	55 LDN (dB) at average 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

** An additional reduction of 10 percent may be possible through improved operational capability
* Concepts that enable optimal use of runways at mutiple airports within the metropolitan areas
EIS = Entry Into Service; IOC = Initial Operating Capability

N+1 Conventional



N+2 Hybrid Wing/Body



N+3 Generation

?

Supersonics Project Metrics

	N+1 Supersonic Business Jet Aircraft (2015)	N+2 Small Supersonic Airliner (2020)	N+3 Efficient Multi-Mach Aircraft (2030-2035)
Cruise Speed	Mach 1.6-1.8	Mach 1.6-1.8	Mach 2.0 Unrestricted Flight 1.6-2.0 Low Boom
Range (nmi)	4,000	4,000	6,000
Payload	6-20 pax	35-70 pax	100-200 pax
Sonic Boom	65-70 PLdB	65-70 PLdB	65-70 PLdb low boom flight 75-80 PLdB unrestricted flight
Airport Noise (cum below Stage 3)	10 EPNdB	10-20 EPNdB	20-30 EPNdB
Cruise Emissions Cruise Nox EI	Equivalent to Subsonic	<10	<5
Other		?	?
Fuel Efficiency	Baseline	15% Improvement	25% Improvement

N+1 "Conventional"

N+2 Small Supersonic Airliner

N+3 Efficient Multi-Mach Aircraft

?

NASA NRA Pre-Proposal Conference, Nov 29

- *Advanced Concept Studies for Subsonic and Supersonic Commercial Transports Entering Service in the 2030-35 Period*
- November 29, 2007, 1-5 pm
- L'Enfant Plaza Hotel, Washington, DC
- Stimulate innovation and foster the pursuit of revolutionary conceptual designs for aircraft that could enter service in the 2030-35 time period. Overcome significant performance and environmental challenges for the benefit o the public.
- Phase I: 12-Months, Phase II: 18 Months to Two Years, with significant technology demonstration

NASA N+3 NRA Kick-Off Session

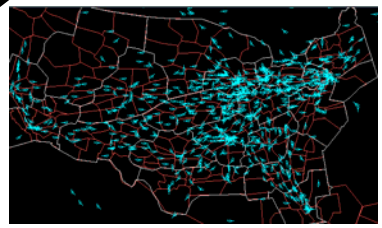
- Six teams have been selected and awards are in place. Four subsonic teams and 2 supersonic teams:
  - Subsonic Ultra-Green Aircraft Research (SUGAR), Boeing
  - Advanced Concept Studies for Subsonic Commercial Transport Aircraft Entering Service in the 2030-35 Time Period, Northrop Grumman
  - Aircraft & Technology Concepts for an N+3 Subsonic Transport, MIT
  - Small Commercial Efficient & Quiet Air Transportation for 2030-35, GE Aviation
  - NASA N+3 Supersonics - Three Generations Forward in Aviation Technology, Lockheed Martin
  - Advanced Concept Studies for Supersonic Commercial Transport Aircraft Entering Service in the 2030-35 Time Period, Boeing

- Kick-off session this afternoon. Open to the public.
- Phase I: 18-Months, Phase II: 18 Months to Two Years, with significant technology demonstration
- Pursuing significant improvements to address some of the challenges of NextGen

Aeronautics Programs

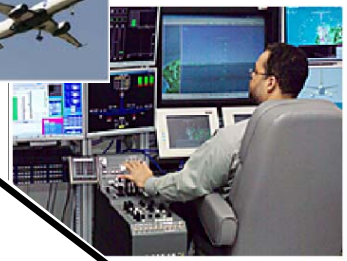
Fundamental Aeronautics Program

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



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.



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.

Integrating Advanced Vehicles into the NextGen

Workshop on
Integration of Advanced Vehicles and Concepts in NextGen
Wednesday & Thursday

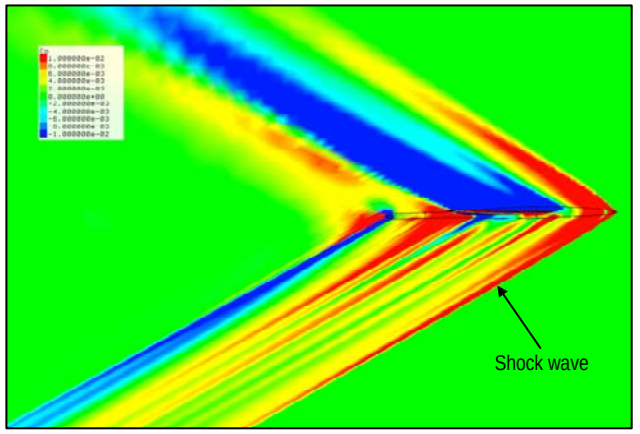
Wednesday 8:00 – 9:00
Overview, Sensis Approach, Raytheon Approach

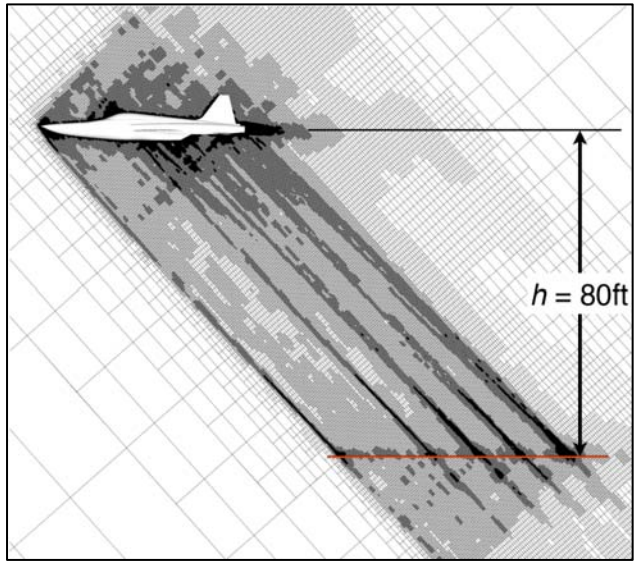
Wednesday 9:30 – 5:30
Breakout Sessions: Rotorcraft, VLJ, Supersonic Transports, CESTOL

Thursday 8:00 –noon
Breakout Sessions: UAV, Safety/Certification Issues
Report-Out/Wrapup

Sonic Boom Prediction Workshop

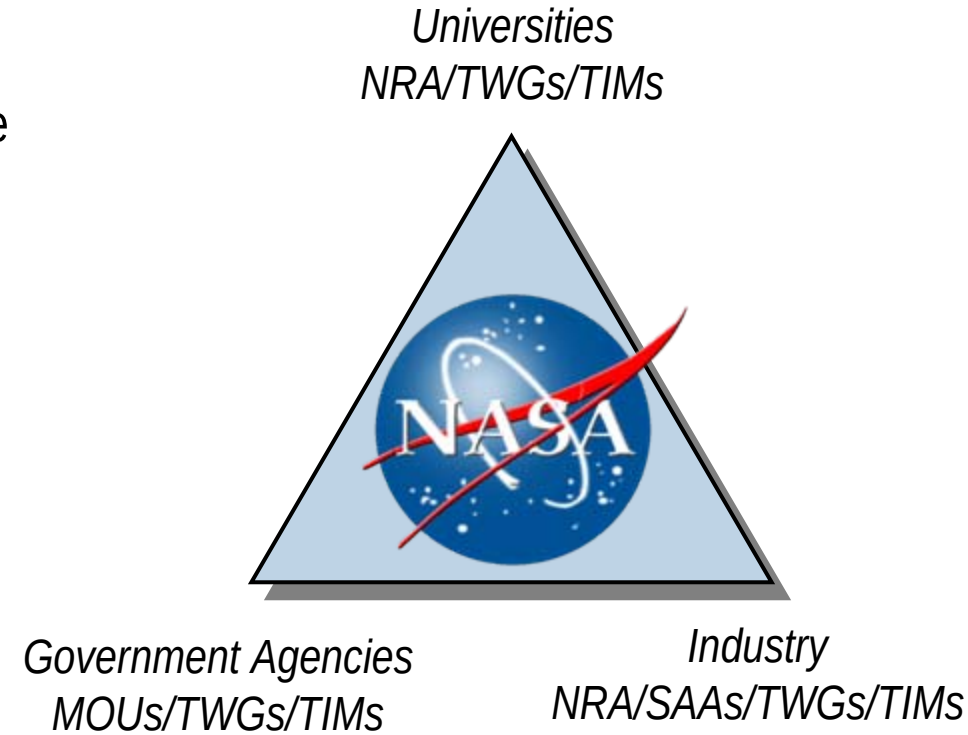
- Presentations / discussion on the state of the art for predicting aircraft sonic boom signatures using advanced CFD methods.
- Intro and case descriptions
- Unstructured, cartesian, block-structured approaches for boom prediction
- Output-based error adaptation
- Summary and conclusions





Partnering Philosophy

- Enhance the state of Aeronautics for the Nation
- Help foster a collaborative research environment in which ideas and knowledge are exchanged across all communities
- Maximize the return on investment to the taxpayer (our main stakeholder)
- Every element of our portfolio targets innovative, pre-competitive research that will advance our Nation's aeronautical expertise
- In accordance with NASA's Space Act (as amended) and the National Aeronautics R&D Policy, we will provide for the widest practical and appropriate dissemination of our research results (consistent with national security and foreign policy)



Learn more about NASA Aeronautics…..

www.aeronautics.nasa.gov

Overview of the entire NASA Aeronautics Program

- Fundamental Aeronautics Program
- Aviation Safety Program
- Airspace Systems Program
- Aeronautics Test Program

www.aeronautics.nasa.gov/fap/index.html

Overview of the entire NASA Fundamental Aeronautics Program

- Subsonic Fixed Wing Project
- Subsonic Rotary Wing Project
- Supersonics Project
- Hypersonics Project