

Aeronautics Research Mission Directorate Air Vehicles, Integrated Flight Systems and Airspace Operations and Safety

Presenter: Barry Sullivan

MD: ARMD

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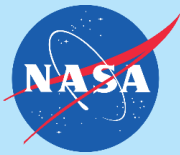
TIME: 00:00 PST

NOTE: All presentations will undergo a review by the MDL and then by ITAR/EAR.

INNOVATION | PARTNERSHIP | COMMERCIALIZATION

SMALL BUSINESS INNOVATION RESEARCH (SBIR) & SMALL BUSINESS TECHNOLOGY TRANSFER (STTR)

The NASA Aeronautics Vision



3 Mega-Drivers



6 Strategic Thrusts



Safe, Efficient Growth in Global Operations

Enable full NextGen and develop technologies to substantially reduce aircraft safety risks



Innovation in Commercial Supersonic Aircraft

Achieve a low-boom standard



Ultra-Efficient Commercial Vehicles

Pioneer technologies for big leaps in efficiency and environmental performance



Transition to Alternative Propulsion and Energy

Characterize drop-in alternative Fuels and pioneer system level electric propulsion technologies



Real-Time System-Wide Safety Assurance

Develop an integrated prototype of a real-time safety monitoring and assurance system



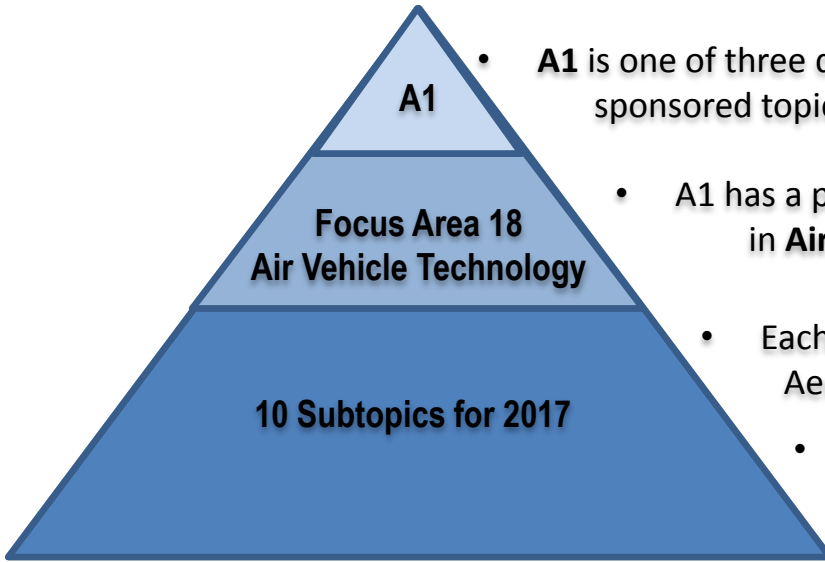
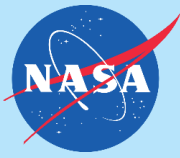
Assured Autonomy for Aviation Transformation

Develop high impact aviation autonomy applications

U.S. leadership for a new era of flight

Topic A1– Aeronautics Research Mission Directorate

Focus Area 18: Air Vehicle Technology



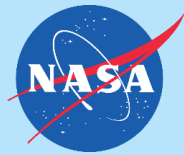
- **A1** is one of three designated areas for Aeronautics Research Mission Directorate sponsored topics and addresses 5 of 6 ARMD strategic thrusts
- A1 has a primary relation in **Focus Area 18** reflecting NASA’s interest in **Air Vehicle Technologies**
- Each Focus Area is broken down into **Subtopics** relevant to Aeronautic Strategies.
- **Subtopics** are updated on an annual basis to identify current needs for the agency, ensure mission relevant proposals and also to save time and effort for all

10 Subtopics for 2017 Phase 1 SBIR’s

➤ Structural Efficiency-Tailored Airframe & Structures	➤ Vertical Lift Technology
➤ Quiet Performance - Airframe Noise Reduction	➤ Propulsion Efficiency-Propulsion Materials and Structures
➤ Low Emissions Propulsion and Power-Turboelectric and Hybrid Electric Aircraft Propulsion	➤ Aeronautics Ground Test and Measurements Technologies
➤ Aerodynamic Efficiency-Active Flow Control Actuators and Design Tools	➤ Vehicle Safety- Internal Situational Awareness and Response
➤ Computational Methods & Tools - High Fidelity Mesh and Geometry Tools	➤ Hypersonic Technology-Improvement in Solar Operability Predictions using Computational Algorithms

Topic A1 Subtopic Strategy

Recurring Subtopic Themes with Rotating Focus and Newly- Proposed

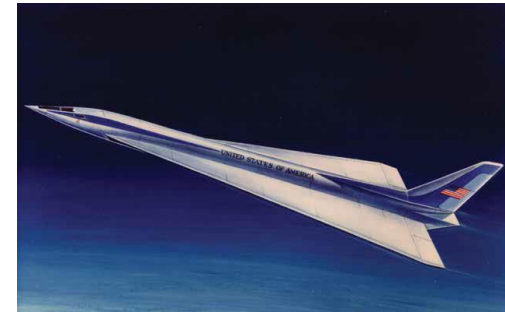


2017	A1.01	Structural Efficiency - Tailored Airframe Materials & Structures	New Focus
2016	A1.01	Structural Efficiency - Aeroelasticity and Aeroservoelastic Control	
2015	A1.01	Structural Efficiency - Hybrid Nanocomposites	
2017	A1.02	Quiet Performance - Airframe Noise Reduction	New Focus
2016	A1.02	Quiet Performance - Propulsion Noise Reduction Technology	
2015	A1.02	Quiet Performance - Airframe Noise Reduction	
2017	A1.03	Low Emissions Propulsion and Power - Turboelectric and Hybrid Electric Aircraft Propulsion	New Focus
2016	A1.03	Low Emissions/Clean Power - Combustion Technology/Emissions Measurement Techniques	
2015	A1.03	Low Emissions Propulsion and Power - Electric/Hybrid Electric	
2017	A1.04	Aerodynamic Efficiency - Active Flow Control Actuators and Design Tools	Refined Focus
2016	A1.04	Aerodynamic Efficiency - Active Flow Control Actuation Concepts	
2015	A1.04	Aerodynamic Efficiency - focus was on skin friction drag reduction	
2017	A1.07	Propulsion Efficiency - Propulsion Materials and Structures	New Focus
2015	A1.07	Efficient Propulsion and Power - Propulsion Controls ...	
2017	A1.05	Computational Methods & Tools - High Fidelity Mesh and Geometry Tools	New Focus
2016	A1.05	Physics-Based Computational Tools - Stability and Control/High Lift Design Tools	
2015	A1.05	Physics-Based Conceptual Aeronautics Design Tools	
2017	A1.06	Vertical Lift Technology	New Focus
2016	A1.06	Vertical Lift - VL Measurement Techniques and Condition-Based Maintenance	
2015	A1.06	Vertical Lift	
2017	A1.08	Aeronautics Ground Test and Measurements Technologies	Essentially same (cross-cutting)
2016	A1.08	Aeronautics Ground Test and Measurements Technonlgies	
2015	A1.08	Ground Test Measurement Technologies	
2017	A1.09	Vehicle Safety - Internal Situational Awareness and Response	New Focus
2016	A1.09	Vehicle Safety - Inflight Icing Hazard Mitigation Technology	
2015			
2017	A1.10	Hypersonic Technology - Improvement in Isolator Operability Predictions using Computational Algorithms	New Subtopic
2016			
2015			

Software Optimizes Designs from Spaceships to Wind Turbines, to Aircraft

HyperSizer structural design optimization software

- ▶ 1980's/ 90s NASA LaRC X-30 ST-SIZE Program was terminated in 1993 due to budget cuts, but NASA was able to continue to support further development of the currently named “**HyperSizer**” design optimization software.
- ▶ Leveraged multiple SBIR awards starting in 2005 through 2016 including Phase 1 and Phase 2 to further develop and explore alternative materials and configurations for both Space and Aero applications.
 - ▶ Versatile and better suited designs for alternative crew capsules
 - ▶ Terrestrial applications for wind turbine blade designs
 - ▶ Alternative heat shield carrier for Orion Multipurpose Crew Vehicle
 - ▶ Supported commercial aircraft designs for Bombardier's Learjet, Global 7000/8000 planes and Virginia Atlantic's Global Flyer
 - ▶ Performed structural integrity analysis fore Federal Aviation Administrations Flight –Worthiness certification
- ▶ Industry use: Boeing, SpaceX, most other American companies designing space transport vehicles as well as many commercial aircraft companies.
- ▶ NASA's licensed software currently earns ~\$4M annually and used by companies in 20 countries around the world for various applications.
- ▶ NASA Aeronautics/SBA SBIR Success Story @ https://spinoff.nasa.gov/Spinoff2016/it_5.html



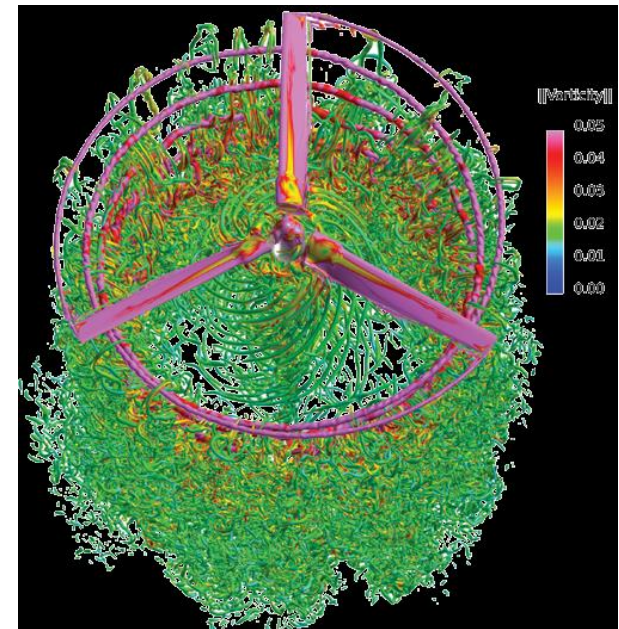
X-30 Supersonic Space Plane
Late 1980's early 1990's project that
was terminated but utilized HyperSizer



Bombardier's Learjet designed by Collier
Research Corporations HyperSizer software

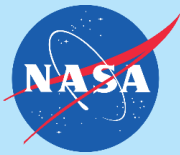
Computational Fluid Dynamics Post Processing Tool “FieldView”

- ▶ Leveraged multiple awards since 1996 securing a total of 13 SBIR contracts from NASA and other Government Agencies including 8 Phase I and 6 Phase II contracts, along with 3 Small Business Technology Transfer
- ▶ Development of “FieldView CFD post-processor tool to create efficient visualization effects of large, unsteady dynamic conditions for gas or fluid substances and their interactions with solids.
- ▶ Various application use for industries such as automakers, defense contractors, and government agencies to streamline workflow processes computationally reducing expensive field testing early in design phases.
 - ▶ Performs highly complex grid simulations for NASA systems including helicopters during approach, hover, and landing on an aircraft carrier.
 - ▶ Performs unsteady calculations and simulations for NASA's new launch vehicles and Mars Lander.
 - ▶ Formula One racing car simulations for structural performance improvements.
- ▶ \$5.4M in SBIR. STTR contracts since 1996
- ▶ NASA Aeronautics/SBA SBIR Success Story @ https://spinoff.nasa.gov/Spinoff2016/pdf/t_4.pdf



NASA's use of Intelligent Lights' FieldView post-processing tool to show airflow around a rotary propeller from a V-22 Osprey. Contains 14,000 grids and 668 million grid points.

Topic Overview – Topic A.2 Integrated Flight Systems



Topic A.2 - Focus on demonstrating integrated concepts and technologies to a maturity level sufficient to reduce risk of implementation for stakeholders in the aviation community.

Subtopic Number/Title	Subtopic Manager/Center	Focus
A2.01 - Flight Test and Measurements Technologies	Richard Hang/Armstrong Flight Research Center	Focused on developing test techniques that improve the control of in-flight test conditions, expanding measurement and analysis methodologies, and improving test data acquisition and management with sensors and systems that have fast response, low volume, minimal intrusion, and high accuracy and reliability
A2.02 – Unmanned Aircraft Systems (UAS) Technology	Jinu Idicula/Armstrong Flight Research Center	Focused on breaking through barriers to enable greater use of UAS in NASA research and in civil aviation use

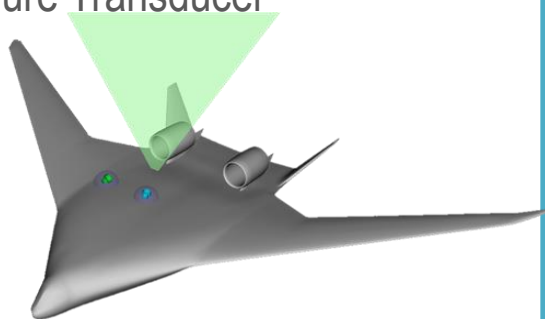
Emerging Capability Challenge: X-Plane Measurement Capabilities (A2.01)

Technologies-

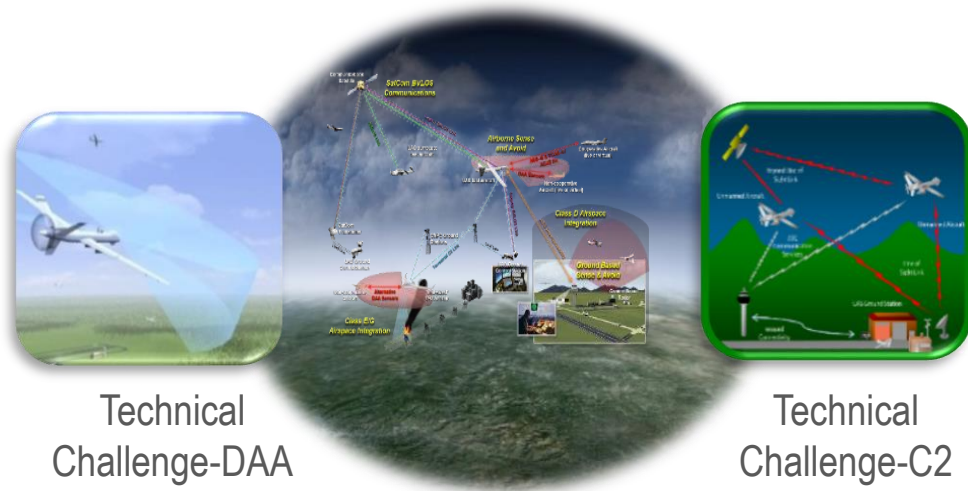
Flight Ready Fiber Optic Strain System (FOSS)

Airborne Particle Image Velocimetry (AirPIV)

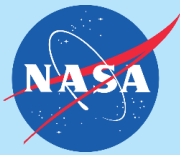
Wireless Pressure Transducer



Technical Challenges: Detect and Avoid (DAA) and Command & Control (C2) (A2.02)



UAS Technologies



Subtopic A2.01 - Flight Test and Measurements Technologies

- Collaborate with Government to identify innovative sensors and measurement techniques to be leveraged for anticipated flight measurement needs
- Supply innovative instrumentation hardware and software to enable in-flight measurements

Technology Examples:

- In-Flight Measurements of Unsteady Pressure using Fast Pressure-Sensitive Paint / Innovative Scientific Solutions, Inc
- A Combined Health Estimation and Active Balancing Electronic System for the Life Enhancement of Batteries in Hybrid and/or All-Electric Propulsion Systems / X-wave Innovations, Inc

Subtopic A2.02 - Unmanned Aircraft Systems (UAS) Technology

- Supply components and sub-systems to enable development of UAS technologies
- Supply feedback on UAS use cases to inform technology development strategy to enable routine UAS operations in the National Airspace System (NAS)

Technology Examples:

- Low-power, ultra-fast deep learning neuromorphic chip for unmanned aircraft systems / Mentium Technologies Inc
- Portable Virtual Aircraft Test System (PVATS) / TMC Technologies of WV Corp
- High-Integrity Safe Autonomy Flexible Innovation Test bed (SAFIT) / Adaptive Aerospace Group, Inc

D8 X-Plane Demonstrator Preliminary Design

Goals

- Complete preliminary design of a D8 demonstrator airframe and conceptual design of the flight vehicle

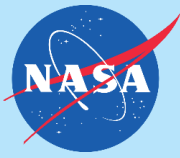
Technologies

- Boundary Layer Ingestion
- Large, unitized, and highly contoured composite fuselage

Partners

- NASA
- **Aurora**
- MIT
- Pratt & Whitney

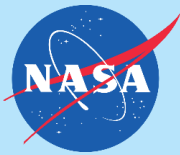




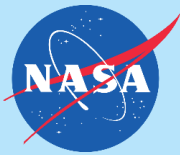
Airspace Operations and Safety - A3

- Seeks innovative and feasible concepts to enable significant increases in the capacity and efficiency of the Next Generation Air Transportation System (NextGen), and future capabilities that go beyond NextGen, while maintaining or improving safety and environmental acceptability.

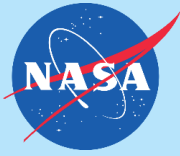
Subtopic Number/Title	Strategic Thrust	Focus
<i>A3.01 Advanced Air Traffic Management System Concepts</i>	<i>Safe Efficient Growth in Global Operations</i>	Conducting the research and development for enabling a modernized air transportation system that will achieve much greater capacity and operational efficiency while maintaining or improving safety and other performance measures
<i>A3.02 Future Aviation Systems Safety</i>	<i>Real-Time System-Wide Safety Assurance</i>	Ensuring that commercial aviation remains as the safest mode of travel in the US building on decades of continuous improvement through proactively managing hazards, incidents, and risks of accidents.
<i>A3.04 Autonomy of the National Airspace System</i>	<i>Assured Autonomy for Aviation Transformation</i>	Conducting research and development of new technologies for the safe integration of UAS in the NAS, verification and validation of innovative systems, advanced human-machine harmonization, and highly reliable trusted systems.



- For *Advanced Air Traffic Management System Concepts, A3.1*, need innovative research to
 - Address user needs and performance capabilities (user preferred services)
 - Trajectory-based operations concepts, and the optimal assignment of humans and automation to air transportation system functions,
 - Advanced concepts to enable new operations and emerging markets.
- For *Future Aviation Systems Safety, A3.2*, need innovative research to
 - Address technologies, simulation capabilities, and procedures for reducing flight risk in areas of attitude and energy aircraft state awareness
 - Develop V&V tools and techniques for assessing the safety of air traffic applications during certification, and throughout their lifecycles, and
 - Techniques for supporting the real-time safety monitoring of safety requirements during operations
 - Develop and demonstrate a class of new prognostic algorithms that are verifiable, thus removing obstacles to their certification and enabling their safety benefits

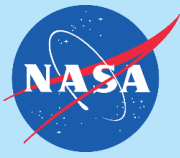


- For *Autonomy of the National Airspace System (NAS), A3.3*, need innovative research to
 - Autonomous and safe Unmanned Aerial Vehicle (UAV) operations for the last and first 50 feet, under diverse weather conditions
 - Autonomous or increasing levels of autonomy for, or towards networked cockpit management, traffic flow management, airport and/or metroplex management, integrated arrivals/departures/surface operations, and low altitude airspace operations
 - Autonomicity (or self-management) based architectures for entire or parts of airspace operations
 - Verification and validation tools for increasingly autonomous operations
 - Machine learning and/or self-learning algorithms for Shadow Mode Assessment using Realistic Technologies for the National Airspace System (NAS)
 - Autonomy/autonomous technologies and concepts for trajectory management and efficient/safe traffic flows
 - Adaptive automation/human-system automation concepts, technologies and solutions that increase operator efficiency and safety, and reduce workload to enable advances in air traffic movement and operations.



- Cybele (Intelligent Automation Inc.) - 2010
 - Cybele is an agent infrastructure framework for modelling complex systems with multiple, individual constituents Cybele forms the agent infrastructure for NASA Ames ACES tool for ATM research
 - Tool also used to support US Army to study leadership development and troop training
- VoiceFlight (VoiceFlight Systems LLC) - 2012
 - VoiceFlight is a speech recognition system to enable pilots to speak waypoints into an airplane's GPS
 - VoiceFlight was basically an interface for a Garmin GPS. Became the first certified FAA speech recognition product for use in general aviation aircraft (2009).
 - VoiceFlight launched WAAS-enabled VSF101 product for smaller GA planes.

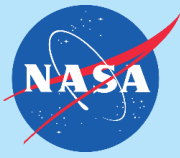
What's New? New Aviation Horizons Initiative



- New Aviation Horizons Video goes here...

- Resource References to other strategies or documents that provide more information and context for this topic:
 - NASA ARMD Web Site www.aeronautics.nasa.gov
 - ARMD SBIR
<https://sbir.gsfc.nasa.gov/solicit/58007/detail?data=ch9&s=58000>
 - ARMD Strategic Implementation Plan 2017
<https://www.nasa.gov/aeroresearch/strategy>
 - NASA ARMD 10-Year Plan
<https://www.nasa.gov/sites/default/files/atoms/files/nasa-aero-10-yr-plan-508-reduced.pdf>
 - ARMD Technology Roadmaps
https://www.nasa.gov/sites/default/files/atoms/files/2015_nasa_technology_roadmaps_ta_15_aeronautics_final.pdf





The End

THANK YOU FOR YOUR PARTICIPATION!

NOTE: *This presentation will be accessible through the Industry Day website.*