Topics

• NASA Aeronautics Research Mission Directorate Strategy & Vision
• Six Strategic Thrusts
• FY15 Program Organization

• Acknowledgement:
  – Thanks to Robert Pearce, Director. Strategy, Architecture & Analysis, Aeronautics Research Mission Directorate
Approach to Planning

NASA Strategic Plan

- Strategic Trend Analysis: Sets the Framework
- Systems & Portfolio Analysis: Develops Concepts, Technical Challenges & Priorities
- Community Dialogue
- Subject Matter Experts: Performs Technical Planning

ARMD Strategic Implementation Plan
Exploring Strategic Trends
Challenges Traditional Approaches

China & India Growing Economically at Historically Unprecedented Rates

The World will be Predominantly Urban

They will have the Largest Middle-Class

Technology Development & Adoption is Accelerating

Source: National Intelligence Council
Why are these trends important?
Challenges are multiplying and accelerating – technology is a key lever!

They drive global demand growth for air travel...

They drive expanding competition for high tech manufacturing...

They enable “leapfrog” adoption of new technology/infrastructure...

They drive resource use, costs, constraints and impacts...
Three Mega Drivers Emerge

Traditional measures of global demand for mobility - economic development, urbanization - are growing rapidly.

Severe energy and climate issues create enormous affordability and sustainability challenges.

Revolutions in automation, information and communication technologies enable opportunity for safety critical autonomous systems.
Century long trend toward urbanization…

Urbanization is occurring at the rate of 7 “Chicagos” a year

Source: United Nations

Century long trend toward higher speed transport…

International Air Transport Association (IATA) – Vision 2050
The world in 2050: “Traffic has grown from 2.4 billion to 16 billion passengers in the last 40 years…Technologically advanced aircraft operating on advanced renewable energy sources and capable of carrying anywhere from 2 to 2000 passengers connect intercontinental traffic through a dozen global gateways feeding them to 50-75 regional hubs which redistribute onwards to local airports.”
Global Competition from New Comers

Research & Development

Brazil’s aeronautical research capacity is still limited in comparison to the US and Europe, but it is expanding and aeronautics is a strategic sector for research investment.

Russia has a very mature and extensive multi-disciplinary aeronautical research capacity.

India’s high quality aeronautical research capacity is limited to a few government and university labs. However, aeronautics research is a sector for strategic investment.

China has been developing its aeronautical research capacity since the 1960s. They have a national aeronautical laboratory system that is composed of over 10,000 technical staff and 2000 senior researchers.

Product Development

Brazil develops and produces world-class regional aircraft, both turboprops and jets. Its largest regional jets can compete in the Boeing 737 class (single aisle transport) market.

Russia develops and produces regional and single aisle transports. Sales are limited, but they are working toward greater global penetration.

India produces aeronautical components, but is also in development of prototype indigenous aircraft as well as the production of aircraft through international partnerships.

China is developing the C919 single aisle commercial transport. China plans to be a major global competitor in aeronautical and aviation products by 2020.

US Industry has invested significantly in establishing research and development capacity and/or partnerships in these developing economies due to market growth realities and to take advantage of global research and innovation.
Escalating Fuel Prices have a Large Aviation Impact

“Fuel is the only major cost item that has become significantly larger over time”
IATA

Source: A4A

Fuel as Percentage of Total Airline Costs

Source: MIT Airline Data Project

Airline Energy Costs Continue to Rise

Source: EIA Weekly Petroleum Status Report for U.S. Gulf Coast jet fuel prices per gallon

Source: A4A
Global Warming Imperative
How do we sustainably satisfy global demand for air transportation?

Global Transportation Contribution to CO₂ Emissions

Global Aviation Industry Plan
(1) From 2009 until 2020: average 1.5% efficiency improvement per year
(2) From 2020: Capping emissions growth from aviation
(3) By 2050: halving net emissions based on 2005 levels

Strategies for Reducing Transportation-Related Greenhouse Gas Emissions
- Reduce the total volume of transportation activity;
- Shift transportation activity to modes that emit fewer GHGs per passenger-mile or ton-mile;
- Reduce the amount of energy required to produce a unit of transport activity (that is, increase the energy efficiency of each mode); or
- Reduce the GHG emissions associated with the use of each unit of energy

Source: GAO

Emissions reduction roadmap

Source: IATA
Technology Convergence
Enabling Assured Autonomy for Safety Critical Systems

Today
Centralized, Expert Operator

Net-Centric Information – Big Data

Tomorrow
Reduce Operations Costs
Improve Performance
Increase Safety
Transform Mobility – On Demand Aviation

More Distributed Management
More System Intelligence
Embedded System Intelligence

Autonomous Systems
Core Technologies support needed capacity growth and enable simultaneous reduction in energy use, noise and emissions

- Structural, Aerodynamic & Propulsion Component Efficiency
- New Configurations
- Automation for Efficient TBO Operations

However, performance gaps remain to fully account for future challenges in mobility, cost and climate

Low Carbon Fuels and Propulsion closes gaps in carbon emissions

Autonomy closes gaps in cost and enables mobility innovation
NASA Aeronautics Vision for the 21st Century

A revolution in sustainable global air mobility.

- On Demand
- Fast
- Intelligent
- Low Carbon
- Safety, NextGen
- Efficiency, Environment
NASA Aeronautics Research Six 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 Low-Carbon Propulsion**
  - Characterize drop-in alternative fuels and pioneer low-carbon propulsion technology

- **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
Proposed Program Reorganization
The Promotion of Innovation and Convergent Research.

Goal 1: Pursue Innovative Solutions Aligned to the Strategic Thrusts
Enable programs to clearly define most compelling technical challenges and retire them in a timeframe that is supportable by stakeholders and is required by our customers.

Addressed through the formation of three Mission Programs and the integration of safety research throughout all programs.

• Airspace Operations and Safety Program
• Advanced Air Vehicles Program
• Integrated Aviation Systems Program

Goal 2: Incentivize Multi-Disciplinary “Convergent” Research
Establish a flexible and organic environment to allow for the development of high-risk, leap-frog ideas to address "big problems." This will allow rapid demonstration of feasibility with high turnover rates, conducted in a convergent, multi-disciplinary, integrated manner.

Addressed through the formation of the Transformative Aeronautics Concepts Program

Goal 3: Enable Greater Workforce and Institutional Agility and Flexibility
• Enable more flexibility to embed flight research throughout research phases and bring back X-plane culture.
• Enable more agile research practices that combine high-fidelity simulation, ground testing, and flight research.

Addressed by embedding the Aeronautics Test facilities and aircraft into the Advanced Air Vehicles and Integrated Aviation Systems Programs.
How are the vision’s research thrusts used?

All of the proposed programs address more than one, or all, of the research thrusts.

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<td>Flight research-oriented, integrated, system-level R&amp;T that supports all six thrusts</td>
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Why a new aeronautics research strategy?

Now is the time to lay the groundwork for the next 100 years of excellence.

• NASA Aeronautics has solid partnerships, high relevancy, and is delivering high impact

• But need to recognize:
  – Rising competition in international R&D
  – Challenges in mobility, energy and climate
  – Opportunities to infuse rapidly advancing non-aerospace sector technologies

• ARMD’s new strategy builds on current leadership and focuses on enabling revolutionary advances

The Time Bomb of Complacency – AvWeek Editorial, September 2, 2013

“An alarm needs to be sounded. A vital and vigorous aeronautics research program is essential… NASA’s unveiling of a new strategy for aeronautics research is a bold and welcome move.”

“Civil aviation [is] blessed with growing demand, record orders and increasing deliveries, but facing global competitors, affordability and sustainability challenges, and an industry-shaking technological revolution.”

Graham Warwick, AvWeek, September 2013
NEW PROGRAM
ORGANIZATION
Program Directors

- John Cavolowsky
  Director, Airspace Operations and Safety Program (AOSP)

- Jay Dryer
  Director, Advanced Air Vehicles Program (AAVP)

- Ed Waggoner
  Director, Integrated Aviation Systems Program (IASP)

- Doug Rohn
  Director, Transformative Aeronautics Concepts Program (TACP)
What is the Airspace Operations and Safety Program?

This program integrates the Airspace Systems Program and Aviation System-Safety work.

Continues Airspace Systems Program research, and the aircraft state awareness research and system wide safety research that was previously conducted within the Aviation Safety Program.

Develops and explores fundamental concepts, algorithms, and technologies to increase throughput and efficiency of the National Airspace System safely.

Provides knowledge, concepts, and methods to the aviation community to manage increasing complexity in the design and operation of vehicles and the air transportation system.

**Proposed Projects**

**Airspace Technology Demonstrations**

**SMART NAS—Testbed for Safe Trajectory-Based Operations**

**Safe Autonomous System Operations**
What is the Advanced Air Vehicles Program?

The Fundamental Aeronautics Program, ground test capabilities, atmospheric environments related safety.

**Proposed Projects**
- Advanced Air Transport Technology
- Revolutionary Vertical Lift Technology
- Commercial Supersonic Project
- Advanced Composites Project
- Aeronautics Evaluation and Test Capabilities

**Mission Program**

- **Advanced Air Vehicles Program**
  - Conducts fundamental research to improve aircraft performance and minimize environmental impacts from subsonic air vehicles
  - Develops and validates tools, technologies and concepts to overcome key barriers, including noise, efficiency, and safety for rotorcraft vehicles
  - Explores theoretical research for potential advanced capabilities and configurations for low boom supersonic aircraft.
  - Conducts research to reduce the timeline for certification of composite structures for aviation
  - Ensures the strategic availability, accessibility, and capability of a critical suite of aeronautics ground test facilities to meet Agency and national aeronautics testing needs.
  - Continues much of the research that was in the Fundamental Aeronautics Program, with a new focus on research that is directly related to the newly defined strategic thrusts. It now houses the Advanced Composites Project that was previously in the Integrated Systems Research Program. It also includes the ground test portion of the former Aeronautics Test Program.
What is the Integrated Aviation Systems Program?

Bridges the gap between technology readiness levels.

- Conducts research on promising concepts and technologies at an integrated system level
- Explores, assesses, and demonstrates the benefits of promising technologies in a relevant environment
- Conducts research into environmentally responsible aviation and unmanned system integration into the national airspace
- Supports flight research needs across the ARMD strategic thrusts, programs and projects
- Completes flight demonstrations
- Coordinates long-term ongoing research with other ARMD programs as done by the Integrated Systems Research Program. Continues the Environmentally Responsible Aviation and UAS in the NAS projects and includes the flight test portion of the former Aeronautics Test Program.

Proposed Projects
- Environmentally Responsible Aviation
- UAS Integration in the NAS
- Flight Demonstrations and Capabilities
What is the Transformative Aeronautics Concept Program?

While mission programs focus on solving challenges, this program focuses on cultivating opportunities.

Transformative Aeronautics Concept Program

Cultivates multi-disciplinary, revolutionary concepts to enable aviation transformation and harnesses convergence in aeronautics and non-aeronautics technologies to create new opportunities in aviation.

Knocks down technical barriers and infuses internally and externally originated concepts into all six strategic thrusts identified by ARMD, creating innovation for tomorrow in the aviation system.

Provides flexibility for innovators to explore technology feasibility and provide the knowledge base for radical transformation.

Solicits and encourages revolutionary concepts

Creates the environment for researchers to become immersed in trying out new ideas

Performs ground and small-scale flight tests

Drives rapid turnover into new concepts

Proposed Projects

Leading Edge Aeronautics Research for NASA

Transformational Tools And Technologies

Convergent Aeronautics Solutions