Transformative Aeronautics Concepts Program

University Leadership Initiative (ULI) Technical Interchange

June 25, 2018
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<th>Time</th>
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A new era of flight is emerging…..
Global Growth in Aviation
Opportunities and Challenges

2017
4 BILLION
PASSENGER TRIPS

41,030
New Aircraft Deliveries
$6.1 Trillion
Market Value

4 BILLION
PASSENGER TRIPS

2036
7.8 BILLION
PASSENGER TRIPS

Airbus / Europe

Bombardier / Canada

Embraer / Brazil

Global Competitors

In 2017, there were 4 billion passenger trips. In 2036, it is expected to increase to 7.8 billion passenger trips.

41,030 new aircraft deliveries were made in 2017, with a market value of $6.1 trillion.

Asia-Pacific market is nearly 40% of new aircraft deliveries.

78% of new aircraft deliveries are single aisle class (including regional jets).

Global Competitors:
- Airbus / Europe
- Bombardier / Canada
- Embraer / Brazil
- Irkut / Russia
- Comac / China
- Irkut / Russia
- Comac / China
Urban Air Mobility
Global Race to Achieve Leadership

Top 20 Megacities

These and many other U.S. and international competitors have the same vision and are capable of innovative vehicle design, development and flight demonstration.

Large projected market—McKinsey analysis of demand by 2030 in 15 major U.S. cities:
- 500 Million annual UAS package deliveries
- 750 Million annual passenger trips

Extrapolation to the global market would likely increase demand by 5 to 10x

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Airspace System
Providing Access and Efficiency to Enable an *Increasingly Broad Range of Business Models*
NASA Aeronautics
NASA Aeronautics Vision for Aviation in the 21st Century

Global Sustainable Transformative

6 Strategic Thrusts

Safe, Efficient Growth in Global Operations
Innovation in Commercial Supersonic Aircraft
Ultra-Efficient Commercial Transports

Transition to Alternative Propulsion and Energy
In-Time System-Wide Safety Assurance
Assured Autonomy for Aviation Transformation

U.S. leadership for a new era of flight

ARMD continues to evolve and execute the Aeronautics Strategy
https://www.nasa.gov/aeroresearch/strategy
The global aviation system of 2040 is emerging today – new companies and new systems built on advanced technologies many with “NASA DNA” and enabled by steady U.S. investment.
Subsonic Transport Technology Strategy
Ensuring U.S. technological leadership

Energy usage reduced by more than 60%
Harmful emissions reduced by more than 90%
Objectionable noise reduced by more than 65%

Prove out transformational propulsion technologies
Prove out transformational airframe technologies

Current Generation
Next Generation - Transitional -
Future Generations - Transformational -

Create technology pathway for U.S. competitive leadership

Image Credit: Denis Fedorko
Image Credit: pig095 from Hampshire, UK
Image Credit: Weimeng
Image Credit: Dan-vip

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Transforming Propulsion – A Breakthrough Opportunity

Turbo-Electric Propulsion Architecture

Boundary-Layer Ingesting Propulsor(s)

Ultra-Efficient “Small Core” Turbofan

In whole or in part, transformational propulsion enables the next generation transitional subsonic transport configuration and enables future generation transformational subsonic transports
Low Boom Flight Demonstrator Strategy
Access to Supersonic Travel

Design and build aircraft with low-noise sonic boom signature characteristics

Verify aircraft low-boom acoustic signature
Class A Airspace

U.S.A.

Asia

Urban Vertiport

HALE UAS

Supersonic Manned Aircraft

Subsonic Fixed wing

Supersonic Manned Aircraft

Helicopter

Airport

Vertiport at airport

Distribution Center

Weather Tolerant Operations

Market: Large UAS & HALE

Market: Thin/Short Haul

Market: Large UAS

Market: Small / Medium UAS

Market: Urban Air Mobility

International Airport

Droneport

Airport

Small airport

Weather Tolerant Operations

Weather Tolerant Operations

Weather Tolerant Operations

Thin/Short Haul Market
Emerging Aviation Markets
Global Race to Achieve Leadership

Urban Air Mobility Example

Ehang - China  E-Volo - Germany  Joby - US

And many other U.S. and international competitors have the same vision and are capable of innovative vehicle design, development and flight demonstration.

The race to capture the market will be won based on...

- Ability to safety certify innovative aviation technologies and configurations
- Achieving equitable community noise standards
- Enabling safe airspace access at high densities
- Achieving safe vertiport infrastructure standards

But most demonstrations and early market growth are overseas – all four key issues easier to manage in many other countries. The U.S. must lead or risk falling behind.

NASA is adjusting its portfolio to address the issues, support FAA and industry to accelerate U.S. competitive posture, and do it through a technically sound, sustainable and scalable approach.
NASA and Industry are already working to respond to these challenges and the deliver the desired outcomes.

Need universities to join in this response.

Seeking ULI proposals that will continue to keep U.S. aviation a leader in 2040 and beyond.
University Leadership in Aeronautics Innovation
Annual NASA ULI Solicitations

- Further the global competitiveness of U.S. aviation industry
- University initiation and leadership
- Integrate diverse participants from the U.S. innovative community
- Students learn through aeronautics research
- NASA investments and Investigator commitments - signals to attract industry investment
- Accelerating progress of technology from the laboratory to the market
- NASA accepts the high risk-high payoff nature of proposed research
Current Teams in University Leadership Initiative

• **Thrust 1:** “Hyper-Spectral Communications, Networking & ATM as Foundation for Safe and Efficient Future Flight: Transcending Aviation Operational Limitations with Diverse and Secure Multi-Band, Multi-Mode, and mmWave Wireless Links,” **PI: David Matolak, University of South Carolina** (NASA POC: Alan Downey, GRC)

• **Thrust 2:** “Adaptive Aerostructures for Revolutionary Civil Supersonic Transportation,” **PI: Dimitris Lagoudas, Texas A&M University** (NASA POC: Larry Cliatt, AFRC)

• **Thrust 3:** “Advanced Aerodynamic Design Center for Ultra-Efficient Commercial Vehicles,” **PI: James Coder, University of Tennessee, Knoxville** (NASA POC: William Milholen, LaRC)

• **Thrust 4:** “Electric Propulsion: Challenges and Opportunities,” **PI: Mike Benzakein, Ohio State University** (NASA POC: Ray Beach, GRC)

• **Thrust 5:** “Information Fusion for Real-Time National Air Transportation System Prognostics under Uncertainty,” **PI: Yongming Liu, Arizona State University** (NASA POC: Kai Goebel, ARC)
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Backups
University Leadership Initiative Strategic Goals

1. Achieve Aeronautics Strategy Outcomes with NASA-Complementary Research

2. Transition Research to Stakeholders

3. Promote Diversity in Aeronautics

4. Provide Opportunities for Students to Participate in Aeronautics Research