Alliance
Webinar:
The Future of Air Mobility

Thursday, December 3, 2020
12:00 p.m. – 1:30 p.m. EST
A World-Class Ecosystem:
Proven disruptive technology assets and expertise to drive innovation as we deploy new, integrated transportation systems.
Awards and Acknowledgements
Data Collection
- Realtime Video (situational awareness)
- Condition Assessments

Logistics
- 1 Hour Package
- Short Haul Logistics/Spraying Applications
- Short-haul - Medium Haul - Long Haul Logistics

Personal/ Business Air Vehicles
- Includes Fractional Ownership Models
- Rural-Urban or Urban to Urban

Air Taxi
- On demand - anywhere to vertiport
- Initially Will Utilize Existing Aerodromes

Air Metro
- On demand and scheduled – vertiport to vertiport

Data Collection
- Rapid response to our dynamic infrastructure
- Improve efficiency and improved safety

Package/Logistics and People Movement
- Reducing the demand of our existing ground transportation infrastructure
- Alternative methods of multimodal transportation options (Resiliency)
- Allowing for more efficient movement and commerce across the state
SkyVision
Ohio’s Ground Based Detect and Avoid
Ohio’s Remote Tower Initiative

- Proposal to participate in a FAA Pilot program
- Rural and small airport enablement in support of General Aviation, economic development and safer airspace.
- Development of an Ecosystem
  - Research
  - Testing
  - Deployment
- Support for AAM
  - Deployment of VTOL aircraft to accelerate the commercial market for advanced air mobility vehicles.
Regional Modeling and Simulation (RMS) – Vertiport Location Assessment – NASA Ames

Location analysis and Modeling and simulation of VTOL operations
- Support for NASA AAM Campaign
- Planning of potential Vertiport locations
  - Engaged local representatives in the Columbus region
  - Location of 7 candidate sites
- Expanding to the rest of the urban centers in Ohio

Further defining business use cases for VTOL technologies
- Better understanding of how the transportation landscape will change
Economic Impact Report for Advanced Autonomous Aircraft Technologies for the State of Ohio

Task 1: Structure the Economic Model
- Assemble Infrastructure Data Elements
- Identify Passenger and Cargo Demand for Ohio Corridors with UAM
- Define Economic Structure and Supply Chain

Task 2: Gather Information on Industry Use Expectations
- Review of Ohio studies and initiatives
- Identification of Key Stakeholders
- Selected interviews of Operators and OEMs
- Develop interview report

Task 3: Define Service and Use Case Scenarios for Demand Estimates
- Package Delivery Scenarios
- People Movement Scenarios
- Assess source and demand constraints for noise pollution
- Document Concept of Operations for 1/71 Corridor

Task 4: Adjust Model and Generate Demand and Benefit Forecasts
- Incorporation of demand, inventories and supply chains
- Validation of operations and assumptions for corridors
- Adjusting investment options
- Adjust assumptions to identify cash flows and determining break even point horizons

Task 5: Perform Analysis with SME Review
- Analyze and adjust use cases based on economic forecasts and break even point horizons

Task 6: Prepare Report
- Draft and Final reports
- Article and research papers for dissemination
Combined Airborne Sensor Network for the State of Ohio to Detect Lower Altitude Aircraft

Interoperable Framework

Clearinghouse

ODOT 12 Month Research Project

Federal Entities
State Agencies
Local Agencies
UTM/USS/PSU

Optical
RF Sensors
Others
• 36 month study for Advanced Air Mobility Technologies
  • Study how AAM will impact, integrate and enhance our 3D transportation infrastructure is an important goal for Departments of Transportation and to prepare for this future of transportation.
  • Specifically designed to study the launch and recovery locations (Vertiports) and their interactions with other (existing and future) modes of transportation for VTOL aircraft technologies.
  • Leverage existing investments, Ohio’s UTM and SkyVision
  • Locations include urban/rural and roadside rest areas as possible multimodal transportation hubs.

• Participants will receive
  • An overview of AAM technologies for each of participants respective political boundaries
  • Provide input and participate in monthly meetings
  • Receive real-time data as the research progresses
  • Acknowledgement in all research publications

• Requested Contributions
  • $175,000 per year for 3 years
  • Total: $525,000
  • An RFP will be released and ODOT will seek the rest of the funding needed

• https://www.pooledfund.org/Details/Solicitation/1513
After years of investing, testing and research -

**UPS launches Medical Drone Delivery**

<table>
<thead>
<tr>
<th>'16</th>
<th>'17</th>
<th>'19</th>
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</thead>
<tbody>
<tr>
<td><strong>Emergency Medical Drone Service</strong></td>
<td><strong>Residential Drone Delivery Test</strong></td>
<td><strong>UPS Medical Drone Delivery</strong></td>
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<tr>
<td>Rwanda &amp; Ghana</td>
<td>Lithia, FL</td>
<td>Distributed Healthcare Systems</td>
</tr>
<tr>
<td>Transportation of postpartum emergency blood transfusions</td>
<td>Tested residential package deliveries using drone launched from the roof of a UPS package car</td>
<td>We see significant potential to drive consolidation across facilities for lab and pharmacy services and to decrease waste associated with overstocking supplies by tightly integrating distributed healthcare systems.</td>
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<tr>
<td>UPS &amp; Zipline</td>
<td>UPS &amp; Workhourse</td>
<td>UPS &amp; Matternet</td>
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**UPS Medical Drone Delivery**
Achieved first commercial revenue flight in U.S. history.
UPS Flight Forward Inc.

Earned the FAA’s first Standard Part 135 US Air Carrier Certificate

Established June 2019

• UPS wholly owned subsidiary
• First revenue generating drone delivery
• First prescription medication drone delivery
• Under Part 135, the only UAS Air Carrier licensed to HAZMAT, including COVID-19 specimens
## Campus Medical Model

Reduced transportation of specimens from up to 2 ½ hours down to 3 minutes

<table>
<thead>
<tr>
<th>Outpatient Clinic</th>
<th>Lab</th>
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<tbody>
<tr>
<td>▪ Specimen collection</td>
<td></td>
</tr>
<tr>
<td>▪ Nurse loads specimens into drone payload box</td>
<td></td>
</tr>
<tr>
<td>▪ Payload is hand carried by UPS to the launch point</td>
<td></td>
</tr>
<tr>
<td>▪ Drone is loaded by a UPS Technician</td>
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</tr>
<tr>
<td>▪ Remote Pilot In Command (RPIC) approves launch &amp; monitors flight</td>
<td></td>
</tr>
<tr>
<td>▪ Drone is unloaded by a UPS Technician</td>
<td></td>
</tr>
<tr>
<td>▪ Payload is hand carried to the lab by UPS</td>
<td></td>
</tr>
<tr>
<td>▪ Specimens tested</td>
<td></td>
</tr>
<tr>
<td>▪ Patient results reported</td>
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</tr>
</tbody>
</table>

1. Specimen collection
2. Nurse loads specimens into drone payload box
3. Payload is hand carried by UPS to the launch point
4. Drone is loaded by a UPS Technician
5. Remote Pilot In Command (RPIC) approves launch & monitors flight
6. Drone is unloaded by a UPS Technician
7. Payload is hand carried to the lab by UPS

**UP TO 2.5 HOURS**

**3 MIN**
UPS Flight Forward and CVS launch residential drone delivery

Helping keep a high risk demographic healthy at home

- Cary, North Carolina, November 2019
  - First drone deliveries of medical prescriptions from a CVS pharmacy to a customer’s home and a retirement community
  - Flown with one-time approval from the FAA

- The Villages, Florida, April 2020
  - Safe and efficient deliveries of medicines to this large retirement community
  - Provide individuals with a convenient alternative to visiting a pharmacy.
  - Also helps prioritize the protection of our healthcare heroes.
Wake Forest Baptist Medical Center, Winston-Salem, NC

U.S. drone delivery industry’s first hub-and-spoke operating model

- Launches drones from one central location to multiple locations
  - Drones operate on two routes, with a phased approach planned to allow the program to expand
- Rapid delivery option for time- and temperature-sensitive medical supplies and PPE
  - Scheduled deliveries of specialty infusion medicines - patient-specific and high-cost, with a short shelf life
  - Individually compounded medicines delivered on demand
  - Personal Protective Equipment to health care providers
Where do we go from here?

- Optimize existing operations
- Build a network of technology partners to develop the next generation of package delivery drones
- Keep safety at the heart of everything we do, with air and ground-based, detect-and-avoid technology
- Working closely with the FAA to realize the benefits of drones, while informing future rules and regulations
- Integration into the UPS Smart Logistics Network

www.ups.com/drones
THANK YOU
Agility Prime Update
Agility Prime Objectives

- **Strategic:** Industrial Base
- **Process:** Acquisition and Airpower Pathfinder
- **Product:** Field VTOL Capability in FY23
ORB: Organic Resupply Bus

Driving value with a maintainable modular mobile electric/hybrid platform

- Like a “Satellite Bus” and “Universal Serial Bus (USB)” standardize/simplify payload integration
- Minimize packing/loading time/infrastructure
- Harness similar efficiencies found with previous DoD logistics system standardization innovations (Conex)

- Reduced reliance on runways
- Reduced parts in theater
- Lower cost for partner sales

Accelerated Capability Development
Surge Capacity
Ohio STTR Participation

- OH Companies:
  - 36 proposals submitted (2\textsuperscript{nd} only to CA)
  - 25 selected - worth $3.7M
    - Spectrum of small business sizes (1-250 employees)

- OH Research Institutions (RIs)
  - Party on 49 proposals (1\textsuperscript{st})
  - 39 selected – worth $5.8M (1\textsuperscript{st})
  - OH RIs partnered with more out-of-state companies than any other state
    - Including largest percentage of CA-based companies
Register to attend AFWERX Accelerate on Dec. 7 to 11

Link to watch live will be posted here on December 7

Register at AFWERX.AF.MIL
Advanced Air Mobility

Parimal Kopardekar, PhD
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Parimal.H.Kopardekar@nasa.gov
1993, Cincinnati

11th International System Safety Conference
Advanced Air Mobility is Emerging

NASA Aeronautics' vision and leadership have stimulated aviation and non-aviation communities to pursue transformative aviation capabilities.

NASA led the U.S. community with the Unmanned Aircraft System (UAS) Traffic Management (UTM) and UAS in the National Airspace System (UAS-NAS) projects.
- Integration of commercial systems is now beginning to emerge.
- UTM is now the accepted concept all over the world.

Urban Air Mobility (UAM) is fast on the heels of UAS integration.
- U.S. industry looking for NASA leadership now to help overcome key barriers to meet aggressive timelines.
- Latest market studies show large market potential — $320B in direct market value over the next 20 years for UAM alone.
- Smart cities integration will drive cross-industry innovation and value generation.
Advanced Air Mobility Mission

Safe, sustainable, affordable, and accessible aviation for transformational local and intraregional missions

UAM Maturity Levels (UML)
- UML-4 Medium Density/Complexity, collaborative and responsible automated systems
- UML-3 Low Density, Medium Complexity, comprehensive safety assurance automation
- UML-2 Low Density/Complexity, assistive automation
- UML-1 Conforming prototypes
• Foundational research partnerships in existence and developing
• NASA/FAA AAM WGs are beginning formal execution

• Continue to Leverage National Campaign (NC) as a centerpiece of the partnership strategy

• AAM Ecosystem Working Groups (AEWG) are providing a valuable opportunity space for localities, international, and standards organizations

FAA, AAM Ecosystem Working Groups (AEWG) and research partnerships are providing valuable input spanning vehicle, airspace, and community partners across the globe
NASA’s Advanced Air Mobility Framework

- Aircraft and Aircrew Barriers
- Airspace Barriers
- Community Integration Barriers

1. Individual Vehicle Management & Operations
2. Vehicle Development & Production
3. Airspace System Design & Implementation
4. Airspace & Fleet Operations Management
5. Community Integration
Opportunities

• National Campaign

• Ohio Advanced air mobility

• Supply chain and manufacturing

• Maintenance, repair, and overhaul network
Modeling Tool

Overall suitability in Cincinnati, OH

Selecting a vertiport in Cincinnati, OH
Simulation Tool

Flight simulation of different vehicles for six locations in OH
Supply Chain S-Curves

Industrial Base: Supply Chain “s-curves”

**Early Stage**
Smaller Quantities
Precertification

**Mid-Stage**
Small – Medium Quantities
Post-production Certification

**Mature Stage**
Medium – Large Quantities
Sustainability

- **Access**
  Access to suppliers for quick early design iterations

- **Resiliency**
  Consistency, continuity, and conformance with multiple suppliers

- **Scalability**
  High production rate to meet growing needs
Challenges

- Castings and forging
- Composites
- Auxiliary Power Units
- Printed Circuit Boards
- Actuators
- Software
- High volume manufacturing and assembly methods
- Many others
Supply Chain for Drones and Vertical Take-off and Landing (VTOL)

Recommendations

- Build modeling and simulation capability to assess supply chain preparedness: gaps, resiliency, scale, and cycle time
- Build a tier system of supply chain all the way to the raw material
- Build an electronic exchange platform to connect VTOL customers with suppliers
- Train workforce: curriculum, skills, and entrepreneurs
Join NASA’s AAM Working Groups!

To register and learn more, visit our webpage:

https://nari.arc.nasa.gov/aam-portal/ (for aircraft, airspace, community integration workgroups)

https://nari.arc.nasa.gov/aamsupplychain

Feedback: arc-cal-nari@mail.nasa.gov

Parimal.H.Kopardekar@nasa.gov
NASA Glenn Research Center

Tim McCartney, Director of Aeronautics

DriveOhio Alliance Webinar
December 2020
Revolutionize mobility around metropolitan areas by enabling a safe, efficient, convenient, affordable, and accessible air transportation system for passengers and cargo.

NASA Glenn’s Contributions:

- Electrified vehicle research and development
- Vehicle Icing for all weather operations
- Acoustics research focused to Community noise acceptance
- Communications systems, architectures and protocols to enable this new domain
- System Security Engineering including Cybersecurity
Glenn Campuses

Lewis Field (Cleveland)
- 307 acres
- 1,467 civil servants and 1,687 contractors
- 94 Pathways Interns (not included above)

Plum Brook Station (Sandusky)
- 6,740 acres
- 22 civil servants and 100 contractors

as of 6/2019
Employees contribute **$9.0 million** in State and Local Income Taxes.

<table>
<thead>
<tr>
<th>Impact</th>
<th>Northeast Ohio</th>
<th>State of Ohio</th>
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</thead>
<tbody>
<tr>
<td>Output</td>
<td>$1.4 billion</td>
<td>$1.5 billion</td>
</tr>
<tr>
<td>Value added</td>
<td>$758 million</td>
<td>$776 million</td>
</tr>
<tr>
<td>Employment</td>
<td>7,185 jobs</td>
<td>7,563 jobs</td>
</tr>
<tr>
<td>Labor income</td>
<td>$501 million</td>
<td>$520 million</td>
</tr>
<tr>
<td>Taxes</td>
<td>$119 million</td>
<td>$124 million</td>
</tr>
</tbody>
</table>

Note: Data from an Economic Impact Study prepared by Cleveland State University, June 2019.
Technologies for Advanced Concepts

NASA Glenn

• Electrified Aircraft Propulsion
• High Power Density Core
• Urban Air Mobility and Aero Communications
• Supersonics and Hypersonics
• Propulsion Acoustics
• Airframe and Engine Icing
• Advanced Propulsion and Airframe Integration
Benefits of Electrified Aircraft Propulsion

Improvements to highly optimized aircraft like single aisle transports

- Enable significant fuel burn reduction from alternative architectures and operational schemes, improved engine cores, and airframe efficiencies.

Help open Urban Air Mobility market

- Provide new vertical takeoff and landing (VTOL) configurations with the potential to transform transportation and services.

Revitalize the economic case for small short-range aircraft services

- Combine electrified propulsion with high levels of autonomous operations to reduce the operating costs of small aircraft and provide economically viable regional connectivity.
Multiple Aspects to Electrified Aviation Propulsion

EAP encompasses more than just electrical systems

Electrical generation, storage and distribution
- Electrical power components (e.g. inverters and motor generators and systems)
- Power storage
- Power extraction
- System architectures

Coupled Turbine Systems
- Small core turbomachinery
- New material systems

System Benefits
- Boundary layer ingestion
- Other propulsion airframe integration
- Systems analysis tools
- Test capabilities

Electrified Aircraft Propulsion (EAP) – the suite of technologies and capabilities that will enable air vehicles to leverage benefits of electricity in their propulsion systems.
Relevant Research Areas for VTOL-enabled Urban Air Mobility

**Propulsion Efficiency**
- High power, lightweight battery
- Light, efficient, high-speed electric motors
- Power electronics and thermal management
- Light, efficient diesel engine
- Light, efficient small turboshaft engine
- Efficient powertrains

**Performance**
- Aircraft optimization
- Rotor shape optimization
- Hub and support drag minimization
- Airframe drag minimization

**Rotor-Rotor Interactions**
- Performance, vibration, handling qualities
- Aircraft arrangement
- Vibration and load alleviation

**Safety and Airworthiness**
- FMECA (failure mode, effects, and criticality analysis)
- Component reliability and life cycle
- Crashworthiness
- Propulsion system failures
- High voltage operational safety

**Operational Effectiveness**
- Disturbance rejection (control bandwidth, control design)
- All-weather capability
- Passenger acceptance
- Cost (purchase, maintenance, DOC)

**Noise and Annoyance**
- Low tip speed
- Rotor shape optimization
- Flight operations for low noise
- Aircraft arrangement/interactions
- Cumulative noise impacts from fleet ops
- Active noise control
- Cabin noise
- Metrics and requirements

**Rotor-Wing Interactions**
- Conversion/transition
- Interactional aerodynamics
- Flow control

**Structure and Aeroelasticity**
- Structurally efficient wing and rotor support
- Rotor/airframe stability
- Crashworthiness
- Durability and damage tolerance

**Aircraft design**
- Weight, vibration
- Handling qualities
- Active control
NASA Glenn is conducting ground-breaking research in Aero-propulsion and technology development in power, propulsion, communications, and materials for extreme environments that will be utilized by current and future aircraft.

Research Areas Include:

- Advanced power and propulsion systems for increased energy efficiency and reduced emissions
- Acoustics solutions to quiet propulsion systems
- Ability to predict and prevent propulsion and airframe icing
- Improved efficient and clean combustion systems
- Turbomachinery concepts and designs for future vehicles
- Advanced materials that enable future efficient environmentally friendly propulsion systems
EXPLORE FLIGHT
NASA GLENN RESEARCH CENTER
Cleveland • Ohio