TRB Webinar: Planning for the Emergence of Urban Air Mobility at Aviation Facilities
February 28, 2024
1:00pm-2:30pm
Today’s Learning Objectives

- Understand UAM and its implications for aviation facilities.
- Recognize the benefits and challenges of integrating UAM within an airport.
- Use best practices and develop strategies to accommodate electric VTOL aircraft.
- Identify the main facility requirements that need to be addressed as part of UAM integration.
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Questions and Answers

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We will read your questions out loud, and answer as many as time allows

#TRBwebinar
Today’s Speakers

Gaël Le Bris, CM, ENV SP, PE  
Vice President, Aviation Planning  
WSP USA Inc.  
gael.lebris@wsp.com

Loup-Giang Nguyen  
Aviation Planner  
WSP USA Inc.  
loupgiang.nguyen@wsp.com
Planning for UAM Services at Airports

Planning for the Emergence of Urban Air Mobility at Aviation Facilities

Gaël Le Bris, CM, ENV SP, PE
WSP USA
What is Advanced Air Mobility?

**UAM**

*Use Cases/Missions:*
- **On-demand intra-urban transportation**
  - VTOL aircraft (1-5 pax or equivalent payload)
- **Last-mile cargo delivery**
  - Small UAS (<250 lbs.)
- **Medical supply delivery**
  - Small UAS (medical emergency supply)

**RAM**

*Use Cases/Missions:*
- **On-demand regional transportation**
  - V/STOL aircraft (5-19+ pax)
- **Heavier air cargo deliveries**
  - Larger UAS (>250 lbs.), STOL
- **Medevac**
  - Larger UAS, V/STOL & CTOL aircraft
What is Urban Air Mobility?

**Use Cases/Missions:**

- **On-demand intra-urban transportation**
  - VTOL aircraft (1-5 pax or equivalent payload)

- **On-demand regional transportation**
  - V/STOL aircraft (5-19+ pax)

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- **Heavier air cargo deliveries**
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- **Medevac**
  - Larger UAS, V/STOL & CTOL aircraft
Market Trajectories

UAM is coming...

➢ **Leading OEMs have built and flown** demonstrators and production aircraft.
➢ **Agreements have been signed with major air carriers** to provide first- and last-miles.
➢ Pre-orders & other agreements signed for **thousands of eVTOLs**.

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**A Possible Scenario to UAM**

**2020-2028**
Aircraft Development and Certification

**2025-2028**
Emergence of AAM Operations

Transition to Automated Flight

Mature AAM Ecosystem

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... But UAM is not here yet!

➢ **AAM is emerging**, No eVTOL certified today (except EHang in China with “conditional” TC).
➢ **UAM does not exist yet** except in primitive forms in some large cities (e.g., NYC, São Paulo).
➢ **Certification pathways are still being defined**. No EASA or FAA TC expected before 2025.
➢ **Over 300 eVTOL projects!** Is there a market for so many models? + “Hirschberg rule”.

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Market Trajectories

UAM is coming... But what does it mean?

- Early UAM operations = crewed eVTOL flying helicopter routes VFR.
- Service reliability requires IFR and straight routes to airport (no hovering).
- Delivering aircraft & recruiting pilots by the thousands... Supply vs demand!
- Insurance cost & innovation premium might hinder “TNC-like” fares as well.
- Airports have limited financial creativity due to grant assurances.

Can we reduce costs further?

Not without enormous shifts in the way we operate aircraft and do business in aviation!
Decision-Making Environment

- Aspirational goal to accommodate UAM.
- Potential market for UAM in my metro/micropolitan area.
- Potential market served by heliports or VTOL-ready facilities.
- Flight operator interested in flying to my airport.
- Flight operator with VTOLs in their fleet ready to fly to my airport.

Speculative

Reality

Risk at Inception

Higher Risk

Lower Risk
Decision-Making Environment

Speculative

- Aspirational goal to accommodate UAM.
- Potential market for UAM in my metro/micropolitan area.
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Reality

We are here
Airport Decision-Making Strategies Available

Speculative

- Gather information and monitor the market.
- Investigate market opportunities.
- Add provisions for vertiport to long-term plans.
- Conduct pilot projects and demonstrations.
- Develop commercial vertiport.

Reality

Risk at Inception
- Higher Risk
- Lower Risk
# A Roadmap to UAM Services

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Short-Term</th>
<th>Medium-Term</th>
<th>Long-Term</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Implementation Stage</strong></td>
<td>UAM strategy development.</td>
<td>Pilot projects and demonstrations.</td>
<td>VTOLs flying UAM corridors.</td>
</tr>
<tr>
<td><strong>Airport Decision Points</strong></td>
<td>Master plan level</td>
<td>Inclusion in CIP</td>
<td>Managing facility</td>
</tr>
<tr>
<td><strong>Type of VTOLs</strong></td>
<td>N/A</td>
<td>Prototypes</td>
<td>Crewed VTOL aircraft</td>
</tr>
<tr>
<td><strong>Current Status</strong></td>
<td>Guidance for UAM planning available</td>
<td>Emerging vertiport design standards</td>
<td>VTOL certification pending</td>
</tr>
</tbody>
</table>
Engaging Communities

➢ **Community buy-in** is crucial for successful UAM integration at airports where environmental & sustainability requirements apply.

➢ Recent examples (e.g., SMO closure decision, NYC anti-helicopter movement, USDOT AAM RFI) highlight the importance of **public acceptance** for such service.

➢ There is a need to **educate the general public** about UAM and **demonstrate** sustainability goals will be met.

➢ **Community engagement** should be meaningful and involve people locally (“showroom at CES is not CE”).

➢ Reaching **public desirability** should be the ultimate goal of UAM implementation.
AAM Planning Process

Type of Aviation Facility
- Vertiport
- General Aviation Airport
- Commercial Service Airport

Create AAM Working Group
- Identify the airport stakeholders involved in AAM operations
- Initiate the execution buy-in
- Determine the needs to implement AAM operations

AAM Operational Model
- VTOL
- STOL
- CTOL

AAM Dedicated Facility
- Vertiport
- STOLport

Utilize Existing Infrastructure
- "Landside" Vertiport
- "Airside" Vertiport

AAM Passenger Terminal

Coordination with MPOs and Local Governments
Community Education and Engagement

Land Use Policies
Maximize Accessibility
Maximize Connectivity
About STOL Aircraft for UAM

- Some AAM aircraft projects explore **Short Take Off and Landing (STOL)** concepts.
- Many eVTOLs can be flown as V/STOL aircraft.
- **Operating STOLs saves energy compared to VTOLs.**
- A runway for small eSTOL aircraft could be as short as 300 ft... It’s like a long FATO than a short runway.
- Strategies for compact STOLports at airports were explored in the 1990s for urban tilt-rotor aircraft.
Can We Get There?!

- São Paulo - Congonhas Airport
- GRU Airport
- Campo de Marte Airport
- Helipark
- Helicidade
- Osasco
- Tatuapé das Artes
- São Caetano do Sul

>400,000 annual operations

>200 heliports across the city

5 miles
Challenges in Airport Operations & Safety

Planning for the Emergence of Urban Air Mobility at Aviation Facilities

Loup-Giang Nguyen
WSP USA
Anatomy of eVTOL Operations

- Approach & Departure
- Taxiing
- Landing & Takeoff
- Deplaning/Boarding
- Recharging/Refueling
- Other Aircraft Services
Anatomy of eVTOL Operational Implications

- Wind Effects
- New Flight Procedures
- More Diverse Fleet Mix
- Jet Blast/Downward Wash
- Occupational Hazards
- Battery Fire Thermal Runaway
- Pedestrian Safety
- Human Factor
- Hydrogen Fire
- Firefighting
- VTOL Rescue
- More Diverse Fleet Mix
The Turnaround Process

- Recharging time will depend on the type of charger (slow or fast charger).
- At airports or large vertiports, autonomous tugs may help eVTOL conserve energy.
- Cabin cleaning increases turnaround time if conducted between consecutive flights.

Preflight Checklist Completed

Recharging/Refueling

Other Aircraft Services

Turnaround Time: 15-25 min.

Boarding

eVTOL Recharged

Take-Off

Taxiing

Landing

Deplaning
Introducing eVTOLs at Airports Safely

Safety First

Airside Risk Management
- Inclusion into airport SMS
- SRA for novel aircraft features
- Safety audits and inspections

Public Safety
- "Landside" vertiport located within public area
- Downwash/outwash hazards

Ground Handling Procedures and Training
- Adapted GH procedures & practices
- Charging/fueling operations
- H₂ storage & distribution
Typology of Facilities

Growing Complexity & Traffic

Vertistation
- 1 FATO/TLOF
- 100 ft. x 100 ft. footprint
- No ground support/service
- Low intensity operations

Vertiport
- 1-2 FATO/TLOF + 2-10 stands
- 250 ft. x 250 ft. footprint
- Limited support/services
- Medium intensity operations

Vertihub
- 2+ FATO/TLOF w/ 10+ stands
- 400 ft. x 200 ft. footprint
- Full support/services
- High intensity operations

Airport
- Runways and FATO/TLOF(s)
- Large footprint
- Passenger & aircraft services
- High intensity w/ diverse fleet

“You’ve seen one airport... you’ve seen one airport”

Sources: LIBELaéro, NASA, NASEM/TRB, WSP
## Typology of Operators and Services

<table>
<thead>
<tr>
<th></th>
<th>Who provides safety management?</th>
<th>Who provides operational safety?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertistop</td>
<td>Flight operators</td>
<td>Pilots</td>
</tr>
<tr>
<td>Vertiport/Vertihub</td>
<td>Flight operators Vertiport operator?</td>
<td>Pilots &amp; ground handlers</td>
</tr>
<tr>
<td>Vertiport Network</td>
<td>Flight operators Vertiport operator?</td>
<td>Pilots, ground handlers, vertiport staff</td>
</tr>
<tr>
<td>Vertiport at Non-Certified Airport</td>
<td>Flight operators Airport operator?</td>
<td>Pilots, ground handlers, airport staff</td>
</tr>
<tr>
<td>Vertiport at Part 139 Airport</td>
<td>Airport, ATCT, Flight operators</td>
<td>ATCT, pilots, ground handlers, airport staff</td>
</tr>
</tbody>
</table>

**Note:** Heliports are not required to comply with Part 139 requirements. Also, Part 139 typically does not apply to airports served by air carriers performing unscheduled operations with small aircraft (<31 seats) and GA facilities.
Typology of Airside Safety Hazards

- VTOL Design
- Recharge/Refuel/Swapping Operations
- VTOL Accident/Incident
- ARFF Ops
- Batteries Heat/Smoke
- Worker/Passenger Trips
- Arcing/Discharge
- Hydrogen Transportation
- Hydrogen Pit Leak
- Hydrogen Storage Leak
Understanding Rotor Downwash

- eVTOLs' distributed propulsion systems may generate unique downwash/outwash patterns differing from traditional helicopter rotor wash.

- Downwash can pose ramp safety and public safety risks.

- Few guidance documents available:
  - Helicopter Rotor Downwash Safety Guidebook (DGAC France)
  - CAP2576: Understanding the downwash/outwash characteristics of eVTOL aircraft (UK CAA)

- Both EASA and FAA have funded research.
Understanding Wind Effects

- Elevated vertiports introduce unique challenges due to wind patterns at elevated locations.

- The wind can significantly impact eVTOL operations, affecting safety and operational efficiency.

- These hazards must be considered when conducting vertiport siting (wind modeling) and when planning flightpaths (microweather forecasting).
Heliport and Vertiport Perspectives

Planning for the Emergence of Urban Air Mobility at Aviation Facilities

Gaël Le Bris, C.M, ENV SP, PE
WSP USA
Anatomy of a Vertiport

- Vertiport terminal
- VTOL taxiway
- FATO/TLOF
- Convenient access to main terminal
- Aircraft stands promoting safety and efficiency
- Safe passenger transit on the airside
- Customer experience from/to the gate
- Compatible with helicopters
- Compatible with VTOL category rather than one model
- Charging equipment
- Microweather monitoring and forecasting
- Fire suppression
- First and last miles
- Can but does not have to be elevated
- Structural considerations

Source: WSP
VTOL/Vertiport Compatibility Criteria

➢ Airfield geometry:
  ▪ FATO, TLOF, safety area, etc.
  ▪ Helicopter routes
  ▪ Type & size of stands

➢ Performance vs. obstacles & procedures

➢ Load-bearing & structural considerations

➢ Ground operations & turnaround time

➢ Power requirements & hydrogen supply

➢ Local communities’ buy-in (public desirability)

➢ Other criteria: ARFF, wind conditions, TSRs, FBO/MROs.

“On the surface achieving compatibility between airports and aircraft seems a relatively simple task. [...] However, the task becomes increasingly difficult as the details of the design are established”

Parsons and Wilfert, 1981
Perspective on Future Fleets

Legend:
- Helicopter
- eVTOL

Source: WSP
VTOL Design Group for Planning Purpose

Source: WSP
State of the U.S. Heliport Infrastructure

- To ensure successful implementation, eVTOL aircraft should be designed to operate from existing heliports.
- About 40% of U.S. heliports* can accommodate VTOLs with a CD=50 ft., and 85% are compatible with VTOLs of CD≤36 ft.
- Uber Elevate's 2016 technical document highlights the significance of a 50 ft. CD, providing access to a large number of heliports and EHLFs in the Los Angeles area.

*34% of U.S. heliports can accommodate VTOLs with a CD larger than 70 ft., many of which are U.S. Department of Defense (DOD) facilities. These are not accounted on this slide.

Source: WSP
Lessons Learned & More

Planning for the Emergence of Urban Air Mobility at Aviation Facilities

Gaël Le Bris, CM, ENV SP, PE & Loup-Giang Nguyen
WSP USA
Early Lessons Learned & Must-Do

- **Manage expectations.** Understand local potential. Admit uncertainty.
- Develop **realistic planning scenarios** rather than highly speculative forecasts.
- Consider groups of **aircraft with similar capabilities** rather than models/brands.
- It’s never too early to **discuss the future** and prevent/limit obstacles...
- ... But business decisions should be **demand-driven**.
- Pilot projects and demonstrations can serve as **low-risk early opportunities**.
- Don’t create isolated vertiports. Consider the **door-to-door passenger journey**.
- Yes, eVTOLs have high power requirements to be **operationally viable**.
To-Do List for the Regulators and the Industry

- **Risk-based standards** on vertiport design enabling **performance-based MOS**.
- **Develop compatibility playbook** across stakeholders (e.g., ACI World ACG).
- Local and national **forecasts** for AAM traffic.
- Incorporate eVTOLs in guidance & tools on **capacity/delay, noise & emissions**.
- Guidance for **urban vertiport planning** including FLM (see ACRP 10-33).
- Guidance for **utility planning** in the era of the Electrification of Everything.
- Guidance to assess and manage **eVTOL downwash/outwash**.
- Strategies to mitigate the **impact of electric propulsion on fuel revenues**.
Further Reading

ACRP Research Report 236: Preparing Your Airport for Electric Aircraft & Hydrogen Technologies

ACRP Research Report 243: Urban Air Mobility: An Airport Perspective
Further Reading

An Airport & Vertiport/Aircraft Compatibility Approach of eVTOL Aircraft Design

Safety Considerations on the Operation of eVTOLs at Airports & Vertiports
Fly safe!

Gaël Le Bris, CM, ENV SP, PE
Vice President, Aviation Planning
gael.lebris@wsp.com

Loup-Giang Nguyen
Aviation Planner
loupgiang.nguyen@wsp.com
Today's Speakers

Gaël Le Bris, CM, ENV SP, PE
Vice President, Aviation Planning
WSP USA Inc.
gael.lebris@wsp.com

Loup-Giang Nguyen
Aviation Planner
WSP USA Inc.
loupgiang.nguyen@wsp.com
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