From Airports to Mobility Hubs:

Leveraging existing infrastructure for AAM

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Introduction

Advanced Air Mobility, or AAM, has burst onto the transportation landscape recently with the promise of transforming how we all get around, taking us to the skies and providing alternatives to aging ground transportation options that have struggled to keep up with demand. The key to this revolution is an entirely new type of aircraft. One that is safer, quieter, more efficient, and more versatile than any small plane or helicopter to come before. Known in the industry as electric vertical takeoff and landing (eVTOL) aircraft, these vehicles have the potential to deliver unprecedented benefits with a fraction of the environmental impact of traditional aviation. Wisk believes engaging with small-to-mid-sized airports and communities is essential to the growth of the AAM industry.

Part helicopter, part airplane, eVTOLs are capable of operating from facilities with a much smaller footprint, making them uniquely suited for urban environments that previously were not possible. This capability creates a unique opportunity for small-to-mid-size community and regional airports to re-engage with local communities and transform their operations from occasional travel to key transportation hubs. Short term infrastructure improvements and operational adjustments have the potential to deliver substantial long-term benefits for airports and their surrounding communities. These small to mid-size airports will play a critical role in the launch and long-term success of the AAM industry.

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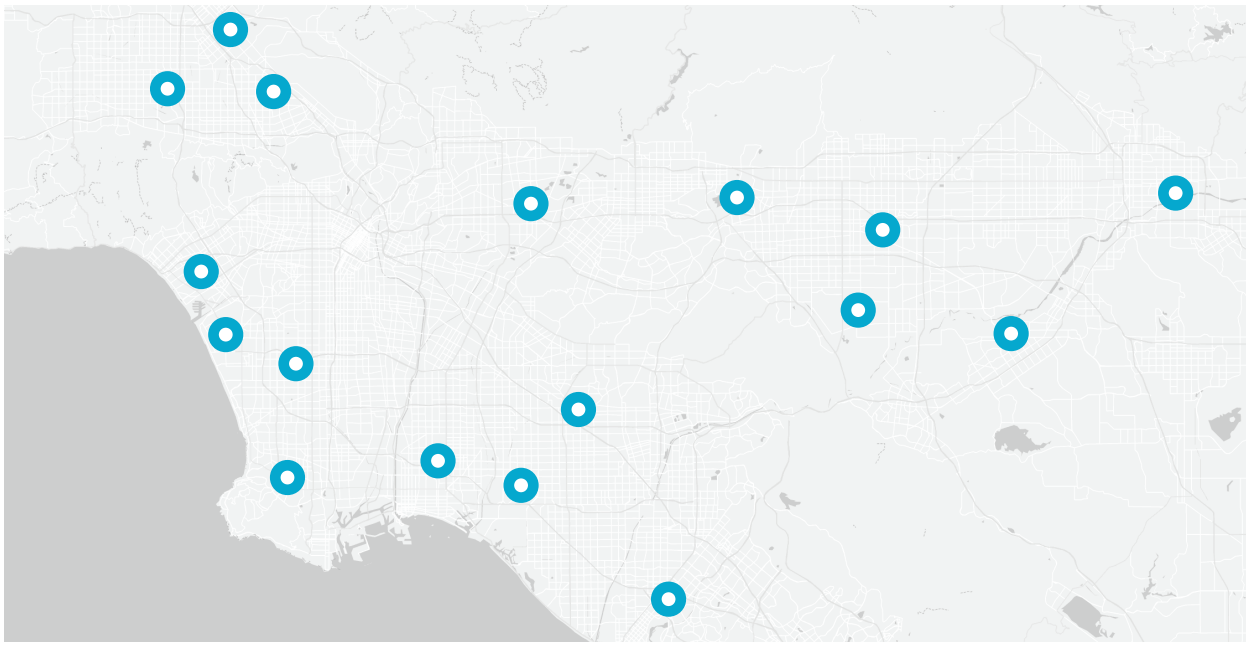
A Place to Takeoff and Land

In order to realize the potential benefits of AAM, eVTOL aircraft need a place to take off and land that is centrally located for future passengers and the places they want to be, without causing substantial disruption to local communities. These vertiports will be part of integrated transportation hubs where many different modes of travel connect, enabling a seamless multi-modal experience for passengers.

While adding vertiports, whether to existing buildings or as part of new transportation development projects, will certainly be necessary for the long term success of the industry, leveraging existing aviation infrastructure is an impactful, safe, and economical solution as eVTOL aircraft enter into service.

In the US there are over 5,000 public use airports, located on average 20 minutes by car from anywhere in the country. While a handful of airports with longer runways that could support jet airliners became commercial hubs, the rest remains largely unused for commercial travel[1]. By integrating eVTOL operations into existing small-to-mid-size airports around the U.S., this infrastructure can be put to new use, benefiting an even larger number of those that live nearby. As a node in a multi-vertiport network, these airports become a key connection point to other modes of transportation and can support multi-modal daily commuters. Passengers catching an airline flight out of the airport can also use the eVTOL service as an alternate way of accessing the airport, reducing the need for surface cars and busses.

EXAMPLE: PUBLIC USE AIRPORTS IN LOS ANGELES



1. NASA's Regional Air Mobility Report, April 2021: https://sacd.larc.nasa.gov/ram/

While new vertiport construction is likely unavoidable in the long term, in order to maximize the value that eVTOL aircraft can bring to a community, leveraging existing airport infrastructure for eVTOL operations in the near term has a number of advantages:

- Land use for aviation has already been established
- Infrastructure for parking and passenger services is already in place
- Other modes of transportation (e.g., buses and light rail) are already connected to the airport
- Electric vehicle charging capacity (and associated energy storage) for electric ground vehicles provides a starting point for eVTOL aircraft charging
- Unused or underused ramp and roof space can be adapted for eVTOL takeoff and landing areas
- Air traffic control and airspace systems and routes are already in place
- Community relationships and communication channels are in place and can be strengthened
- Existing noise abatement procedures already exist for most small to mid-size airports

All of which results in airport-integrated vertiports that can be deployed faster and more economically than new construction sites. They are also expected to have a higher rate of community acceptance, which may pave the way for new vertiport sites.

2

Opportunities for Existing Airports and AAM

Operations at small-to-mid-size community and regional airports are typically divided by the operating requirements under which they fall. Private and general aviation flights under 14 CFR Part 91, commensurate with their generally smaller aircraft size, relatively less passengers, use for non-commercial transport, are the least regulated operations. And while they can include some commercial purposes, they are typically individual flights. On the other end of the spectrum lie scheduled airline flights under 14 CFR Part 121. These are what most people think of when picturing commercial aviation. In between are on-demand flights that fall under 14 CFR Part 135.

Due to the lower environmental and noise impact of eVTOL aircraft, eVTOL aircraft have the potential to provide even closer connectivity between the airport and its surrounding communities. By connecting the airport to other transportation hubs and natural gathering places, eVTOL flights can skip over ground transportation bottlenecks for airport access making it easier for passengers to arrive at the airport for their commercial airline flight.

Transfer passengers can also be joined by commuters — community members using the airport eVTOL hub as a connection point to other vertiports in the network. For some people, particularly those who are not themselves pilots, eVTOL access may be the first time they've ever used their community airport. This increased utility and exposure of the local airport is expected to build support for the facility in the surrounding community: public acceptance hinges on perceived benefit.

It is easy to see the opportunities that exist for airports by leveraging existing regulations and operations. Realizing these opportunities will not only benefit the airport and local community but will support the future of AAM.

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Key Considerations for Airports When Integrating AAM

While incorporating eVTOL aircraft into the daily operations at small-to-mid-size airports has the potential to bring significant benefits to the airport and its surrounding communities, maximizing the long term value of those operations requires some upfront planning. As the AAM industry matures, an ever greater number of eVTOL aircraft will be deployed, requiring growing incremental modifications to the existing aviation environment. The anticipated progression from early, limited use cases to ubiquitous daily travel by eVTOL is often referred to as “crawl, walk, run”. By getting ahead of some of these considerations during the “crawl” phase of the industry, airports can set themselves and their communities up for maximum eVTOL value in the “run” phase. However, it is important to note that initial proof-of-concept type flights may require little if any changes to the current infrastructure and systems.

Environmental Impacts

Every form of transportation has some level of adverse impacts associated with it. From driving our cars, to fire truck lights and sirens, to air medical flights, it's simply not possible to move people and goods without some impact, whether it be noise, visual, or emissions. The key is to both mitigate these impacts and to demonstrate that they are "worth it" to the community by providing a real benefit to as many people as possible.

Noise is a classic example of an adverse environmental impact. While eVTOL aircraft can be both significantly quieter than most other current airport operators and have a less noticeable audio signature, they are not completely silent. Mitigation techniques for AAM-related noise include limiting times of operations so that they are not flying too early in the morning or too late into the evening. Additionally, and particularly for eVTOL aircraft that are equipped with enhanced autonomy, flight paths can be developed to keep the noise footprint of the aircraft to areas that already have higher ambient noise — like directly over a highway — and then flown very precisely.

A key factor as to whether or not a community finds aircraft noise from its local airport acceptable is how much value the members of that community feel they stand to receive from those aircraft operations. A classic example is an air medical evacuation or a firefighting flight: they are just as noisy as private flights for the wealthy, but more people can identify with potential benefit to themselves or their loved ones for the first responder flights and are thus less likely to complain about the resulting noise, even if audibly it is the same.

In addition to noise, visual impacts can be felt by surrounding communities. More research needs to be done to determine acceptable altitudes for flight of eVTOL air taxis. Depending on lessons learned from early demonstrations and experience with eVTOL aircraft, flight and approach/departure paths may be developed to maintain a certain height above the ground so as to minimize visual impacts on people on the ground. Another advantage of having predefined and predictable flight paths could be to contain the visual impact of eVTOL aircraft to areas where the community comes to expect to see them.

Airspace Coordination and Routing

While careful route planning is a key tool in mitigating potential environmental impacts, it is also critical for the utility and safety of the AAM system. The small-to-mid-size airport would be one of many nodes in an AAM network and, naturally, routes would need to connect the airport to those other takeoff and landing locations. These other locations could be other airports, existing heliports, or purpose-built facilities developed as part of the AAM roll out in a community (e.g. "vertiports"). The placement of these secondary nodes is critical to the success of the system and should take into account considerations such as inter-modal transportation connectivity, social equity, surface transportation bottlenecks, local land use regulations, and of course passenger demand. Additionally, the airspace surrounding these secondary nodes needs to be evaluated to ensure that safe approaches and departures can be made based on the eVTOL aircraft performance capabilities.

Once the non-airport nodes in the network are identified, routes need to be planned to connect them. Air traffic controllers, transportation planners, community members, and other airspace users should all be part of this conversation to ensure that the considerations discussed above are appropriately considered. The best route between two nodes may not be a straight line. As communities explore AAM and develop their network, it is acceptable in the "crawl" phase to only have one or two other nodes in a network with the airport in order to gain familiarity with the system and build community acceptance.

Airspace Coordination and Routing (continued)

For small-to-mid-size airport operations, air traffic control (ATC) will need to be consulted as to their preferred method of working with the eVTOL traffic. One possibility is to have predefined routes or non-exclusive 'corridors' in which the eVTOL aircraft can fly and ATC will simply keep other traffic away from those corridors without closely monitoring the eVTOL aircraft themselves. The eVTOL aircraft would then be left to work with a third party service provider or use vehicle-to-vehicle communications for traffic deconfliction. Another possibility is that ATC will want to have direct control over each eVTOL flight. If this is the case, the onboard automation or eVTOL operator needs to accommodate ATC requests.

These considerations are of course closely related to the number of eVTOL aircraft operating in a given community or at a given airport. Many small-to-mid-size airports do have limitations on the number of aircraft operations that they are allowed to accommodate on a daily basis, but typically these limitations do not encompass Part 91 or Part 135 operations, meaning they do not directly apply to eVTOL AAM flights. Airports, eVTOL operators, and communities need to have a robust dialogue about the appropriate number of operations that can be added to an airport's existing traffic, keeping in mind that some eVTOL operations may be in lieu of existing helicopter flights or surface traffic and that if sufficient flight volume isn't achieved, broad community benefit (and therefore acceptance) may not be achieved.

Looking ahead, both the FAA[3] and NASA[4] have published concepts of operations (CONOPs) describing potential airspace integration techniques for AAM for later-stage operations; the path from today to those visions still has a lot of flexibility and must be determined at least in part at a local level.

3. https://nari.arc.nasa.gov/sites/default/files/attachments/UAM_ConOps_v1.0.pdf
4. https://www.nasa.gov/aeroresearch/uam-vision-conops-uml-4

Infrastructure Considerations

The four main infrastructure considerations are:

- Electrical grid capacity and charging capability
- Takeoff and landing locations
- Landside (e.g., parking) and airside (e.g., secure area) access
- Emergency response equipment

The electrification of the ground vehicle fleet and the charging infrastructure that is already being added to the parking facilities at small-to-mid-size airports is a good first step as the needs of eVTOL aircraft are being considered. Airports that are not yet pursuing such activities should consider this if hosting eVTOL services is something the airport desires in the future. For operations in the "walk" phase of AAM — consisting of roughly 100 aircraft operations a day — dedicated charging capability on the order of 4,500 kW is anticipated to be needed. This level of operations will likely need less than 6,000 square feet of dedicated space for a takeoff and landing zone to support a meaningful number of aircraft at any one time. Just as many helicopter operations today are conducted from ramp space or other areas at an airport that are not officially designated as a "heliport," it is expected that at least in the early phases of eVTOL integration a similar organic approach will be taken for on-airport operations.

When considering integrating eVTOL passengers into the flow of the small-to-mid-size airport, whether the aircraft land on the secure airside of the field or on the more open landside is a key question. While the potential for off-field screening and airside access is intriguing, landside operations provide the greatest flexibility for both transfer and transient passengers. Transient passengers could connect to another eVTOL flight or ground transportation without increasing the TSA burden while transfer passengers, by virtue of having purchased a commercial airline ticket, are already included in the required TSA capacity estimates. The parking needs of transient passengers are expected to be offset by the transfer passengers that are arriving at the airport for their commercial flight without surface transportation.

Another piece of airport infrastructure which needs to be evaluated against the needs of eVTOL operations is emergency response equipment. Due to the electric nature of the aircraft and batteries on board, firefighting equipment needs to be able to accommodate potentially different emergency situations than those that would arise with conventionally fueled aircraft. While the aircraft are designed to be safer than traditional small aircraft thanks to distributed propulsion and autonomy, it is nonetheless essential that airport emergency responders coordinate with aircraft manufacturers and operators to ensure proper equipment and procedures are in place.

Community Relationship Management

While small-to-mid-size airports were built with the intention of being key assets for the communities they serve, the relationship between airports and their neighbors is often a fraught one. Noise complaints top the list but concerns over privacy, emissions, and other adverse impacts are also sources of contention. As urban areas have expanded and population increased around airports, tensions have arisen. These tensions often go unmitigated by perceived community benefit, which is essential for public acceptance. Successful airports are active in managing their relationships with their surrounding community.

Key Considerations for Public Acceptance

Public acceptance is achieved when four key pillars are accomplished: trust, public benefit, integration, and limiting (or mitigating) adverse impacts[5]. Trust is built through safe vehicles and safe/secure operations. Public benefit has been discussed above and can be demonstrated through emergency services, increased travel options, and economic opportunities. Integration means connecting the airport and the AAM service to other existing forms of transportation and natural passenger flow patterns but also grid connectivity and social equity considerations. Limiting adverse impacts covers many of the considerations discussed above.

Lessons Learned from History

New modes of transportation are often met with resistance. Even automobiles were considered dangerous interlopers that were only for the elite when they were first introduced[6]. However, as infrastructure evolved and automotive traffic was better integrated with pedestrians and other users of city streets, safety increased. As prices came down more and more cars entered our cities, it became in the direct personal interest of more and more people to figure out how to integrate them successfully. Broad public education campaigns were key, but most importantly were innovations like sidewalks and traffic lights which separated cars from pedestrians and which provided the "rules of the road" for automotive traffic deconfliction. Similarly, airspace integration and other operational considerations will facilitate the adoption and acceptance of eVTOL aircraft.

Looking specifically at aviation, it is important to not get behind in community relationship management. Once an airport falls out of favor with a community it is exceptionally difficult to regain support, particularly in the current environment where general aviation is of visible direct value to so few members of the general public. As such, it is imperative that AAM operators and airports incorporate public engagement and education into their planning activities from the beginning.

5. The Community Air Mobility Initiative (CAMI)'s "Components of Public Acceptance for AAM and UAM": https://www.communityairmobility.org/resourcefiles/components-of-public-acceptance-for-aam-and-uam
6. "Fighting Traffic: The Dawn of the Motor Age in the American City" by Peter D. Norton

Community Relationship Management (continued)

Tools to Use to Build Support

Fundamentally, if benefit to the community is not demonstrably provided by eVTOL aircraft, support will be hard to come by. Assuming that there is concrete benefit to be had, engaging with the community around the four pillars of public acceptance (trust, benefit, integration, and mitigation) to ensure a dialogue is active is key. Measuring and being transparent about actual adverse impacts, holding meetings with the community at large and with interest groups, and educating the public through videos, online FAQs, and other channels are all important tools to build partnership. Emergency services applications, job creation, and other broad societal benefits of eVTOL should be featured.

Additionally, as mentioned earlier, communities should also have a voice in the placement of the other takeoff and landing sites in the AAM network that utilizes the small-to-mid-size airport. When considering the placement of these nodes, it is important to consider not just geographic or even demographic factors but also surrounding land use — both current and allowable. Oftentimes if land surrounding an airport is not appropriately protected from residential development, new residents move in without realizing the noise impact of the nearby airport and then find themselves complaining about operations that may have been unchanged for decades.

As with traditional aviation, eVTOL air taxi use will evolve, with price decreasing as adoption increases and autonomous operations enable the industry to scale. The speed with which the industry can get to an era of greater accessibility and adoption will be crucial to the long term acceptance and success of AAM. Public demonstrations and other direct in-person outreach efforts will be important to get through the “crawl” phase of implementation.

Legal Interpretations of Ordinances

In addition to the perceived impact of eVTOL operations on the communities surrounding the airport and the qualitative concept of public acceptance, compliance with local ordinances, including those on noise, is crucial. Noise ordinances can cover things like what times during the day operations are allowed, what the maximum noise impact of a single event is allowed to be, the maximum sustained level of noise impact, and the total number of various types of operations that are allowed at an airport. As with many regulatory considerations, these noise ordinances were not written with eVTOL aircraft in mind. Interpreting them appropriately for these new aircraft will require both technical and legal expertise.

4

Summary and Top Recommendations

We are entering a new era of personal air travel that promises safer, quieter, more affordable, and more efficient flight. Advanced Air Mobility and the eVTOL aircraft at its core have the potential to make everyday flight a reality for everyone, creating a significant opportunity for the thousands of small-to-mid-size airports around the country. These airports can provide a new, direct, daily benefit to their communities by integrating eVTOL flights into their operations. This simultaneously increases the value of the airport to its neighbors and provides a nearly turn-key infrastructure solution from which to, literally, launch a transportation revolution.

In order to deliver on the promise of this next revolution in aviation, it is critical that both airports and the AAM industry partner today to address key considerations for the integration of AAM services. By working together, airports and the AAM industry can remain good neighbors and strong partners with their local communities, while also ensuring the maximum positive impact for all.

AAM airport integration considerations should include:

- [ ] Equity of access
- [ ] Adaptation of existing infrastructure to accommodate electric charging needs
- [ ] Vertical takeoff and landing zones
- [ ] Airspace integration
- [ ] Passenger connectivity for both transient and transfer passengers
- [ ] Route design
- [ ] Potential adjustments to existing noise abatement procedures
- [ ] Other nodes in the AAM network placed to maximize the value that the system adds to the community
- [ ] Multi-modal connectivity

Continue the Conversation

We encourage airports that are interested in being leaders during this transformative phase of aviation to engage with OEMs and the industry directly.

Contact us at: world@wisk.aero

Learn more at: wisk.aero

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