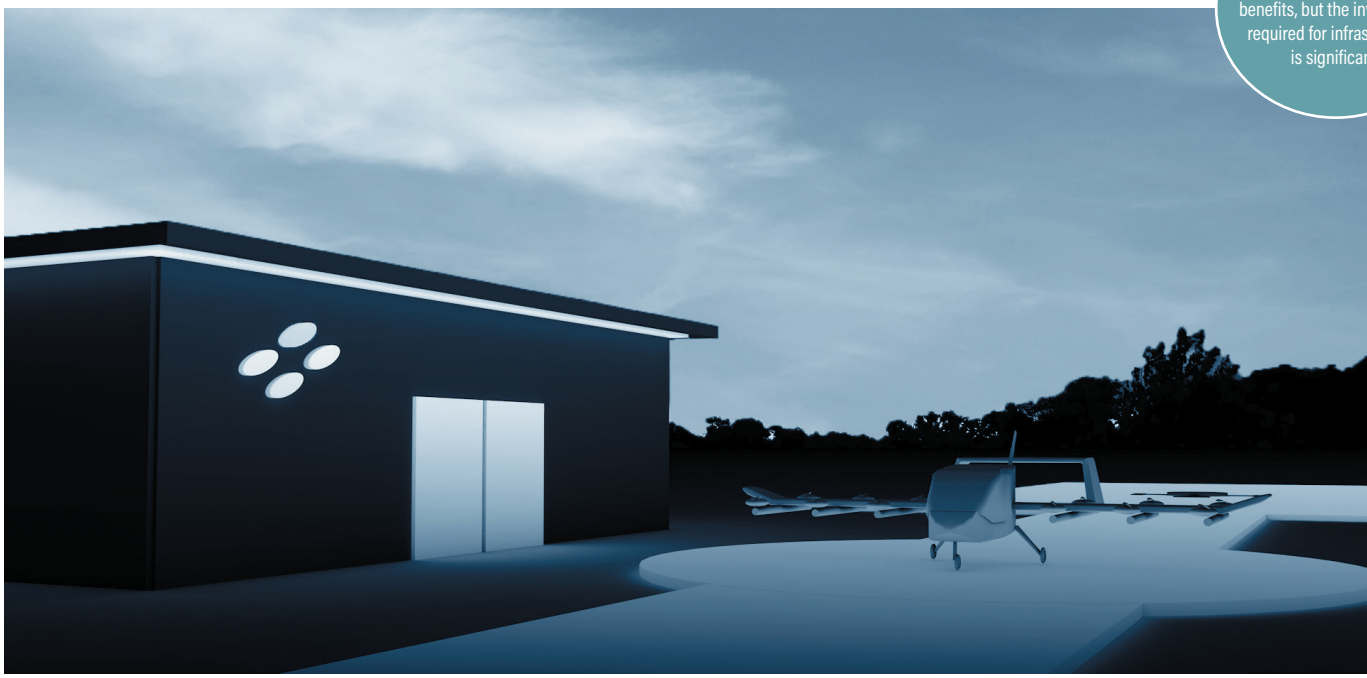


eVTOL aircraft offer communities several benefits, but the investment required for infrastructure is significant

SIMULATION IS THE FIRST STEP TO VERTIPORT PLANNING

Engineers are using the latest simulation tools to plan eVTOL aircraft networks in urban areas

Kenneth A Reed, Skyway and Gustavo Mercado, Transoft Solutions

Electric vertical takeoff and landing and short takeoff and landing aircraft, collectively referred to as eVTOLs, are currently being developed.

Within a few years their developers hope to have the aircraft certified for public transportation by the Federal Aviation Administration (FAA) and other regulatory bodies around the globe. These vehicles allow passengers more options and opportunities for local and regional air travel. They also generate zero carbon emissions and operate more quietly than helicopters.

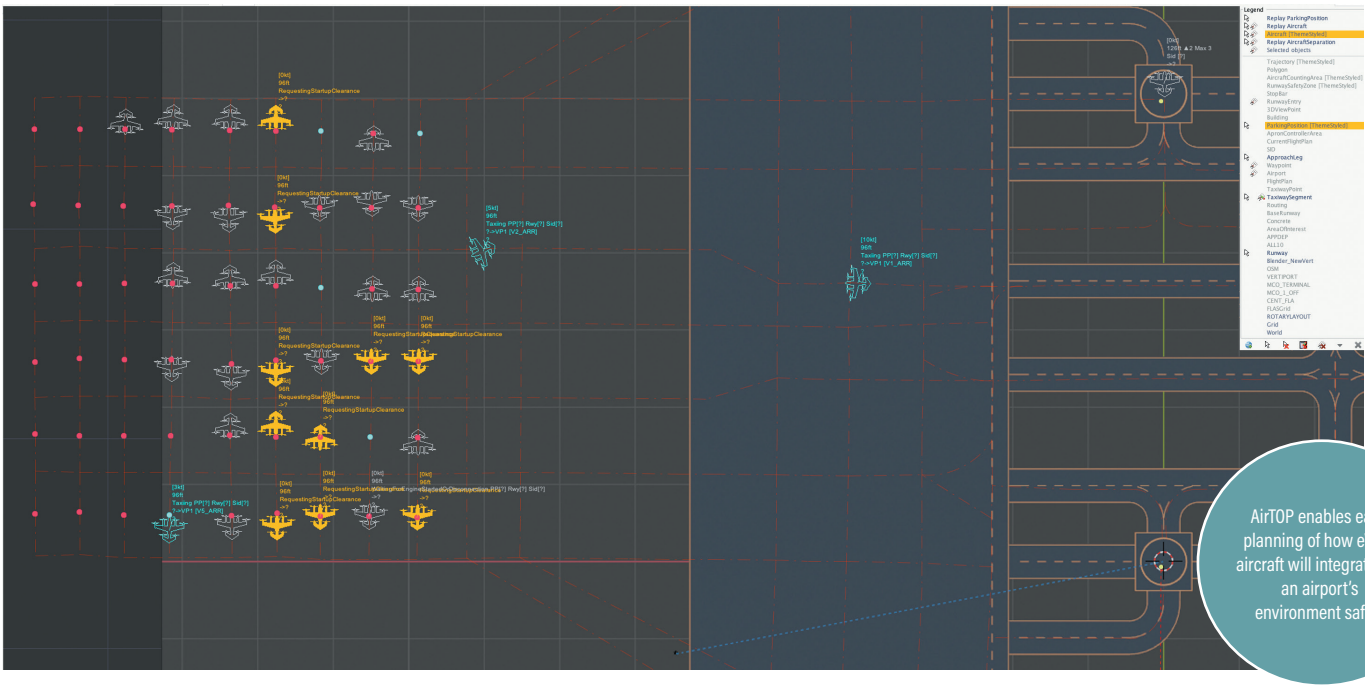
Facilities that cater to eVTOL aircraft are called vertiports. In the USA, the FAA issued draft vertiport planning standards that address the facility design needs of nine eVTOL aircraft in development. The final vertiport advisory circular "A/C" is expected in 2024, but the industry isn't waiting for final design standards. Design is an iterative process in which engineers test, analyze, and refine their plans until the proposed solution provides the appropriate balance of safety, quality, functionality, and expense. For decades, engineers have used simulation to evaluate their proposed designs, especially when testing in real-life is impossible. Results are then presented to stakeholders using statistical analysis, reports and graphical animations.

AirTOP, developed by Transoft Solutions is an established fast-time simulation tool that allows modeling of air traffic, passengers, baggage and ground vehicles at existing or proposed airports. Regulatory bodies around the globe have used AirTOP to prototype, test, analyze and refine the concepts of air traffic operation that today allow air navigation service providers and airports to handle twice the amount of air traffic that was observed 20 years ago. Recently, Transoft Solutions developed additional functionality to their tool to allow planners to model and simulate vertiports.

Skyway provides services to Urban Air Mobility (UAM), specializing in low-altitude air traffic management services for all drone and urban air mobility flights. Its systems provide coordination of vertiports and drone facilities to determine safe and secure flight routes, deconfliction, weather information, sequencing, and clearances for landings and takeoffs. Skyway's vertiport simulations have addressed infrastructure needs and airfield layouts by measuring capacities and identifying potential delays.

Typical flight distances

To be successful, eVTOL air taxi services must be fast and economical, because passengers will be choosing between the eVTOL aircraft or a car. Since there are inherent delays from the system, such as travel to the vertiport and boarding, it is assumed that UAM flights will be most popular when significant time is saved compared to traveling by car. And since



AirTOP enables early planning of how eVTOL aircraft will integrate into an airport's environment safely

these electric vehicles have a limited range, all flight routes will have a minimum range for profitability and a maximum range for feasibility and safety. Naturally, there will be added expenses to consider as well when planning a trip. These travel decisions will include numerous variables which must each be examined to develop a successful system.

AirTOP can effectively analyze network travel distances, test different options like minimum and maximum flight distances, and accurately demonstrate the results with effective replay animations.

A network of vertiports

A community that adopts and develops UAM successfully won't have only a single vertiport. Rather, it will develop a vertiport network to provide the public with varied travel options. Passengers will use the network by requesting a flight using an app on their smartphone. A vehicle will accept the trip, land to load passengers, and then takeoff to deliver them to their destination, much like existing passenger ride-hailing services Uber and Lyft.

Vertiports in the network will have varying sizes and provide varying passenger service levels. A small, rural vertiport with little traffic might have only a single takeoff and landing (TLOF) pad and limited passenger services, if any. These are called "vertistops" and are the equivalent of bus stops.

Larger vertiports, ideally located near business centers, shopping malls, or special event sites like stadiums or convention centers will benefit from larger facilities that can serve their customers' demands without exceeding the airfield's capacity. Passenger facilities and services may include restrooms, restaurants, and convenient connections to other local transportation modes like buses and trains.

In larger communities, passengers may want to travel further than the expected maximum travel distances for these aircraft, requiring a need for "vertihubs" so passengers can connect to other flights. Vertihubs have multiple takeoff and landing areas to maximize their throughput. Vertihubs also allow passengers going to a single destination to be grouped together, allowing for more efficient travel and higher revenues for the fleet operator.

Finally, there will be a need for overnight storage, charging, and maintenance facilities which are referred to as "vertiparks". General aviation airports will be ideal vertiparks. Their real estate is less expensive than at a downtown vertiport, and these new vehicles will integrate more easily with smaller fixed-wing aircraft which are slower, more like the eVTOL vehicles.

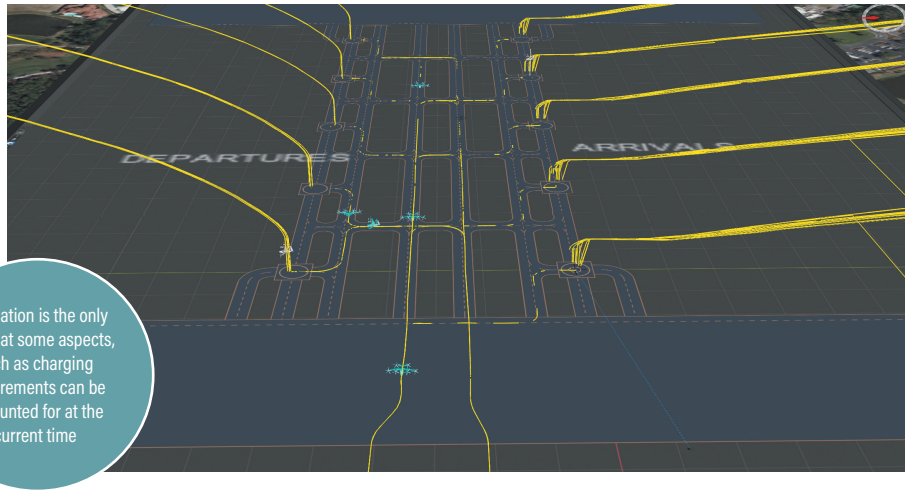
AirTOP allows today's planners to study the integration of these new vehicles and services into the fleet. Using preliminary planning assumptions, initial simulations have already identified a need for at least 10 parking spaces per arrival landing area when some flights remain on the vertiport to charge between flights. This assumes an arrival rate of 20 flights per hour, per arrival TLOF. Other factors, like charging time and frequency, taxiing time and distance, and passenger loading and unloading times were included in this calculation.

Air vehicle parking demands may be even higher at special event facilities because vehicle operators may prefer to park the aircraft at the vertiport during the event, rather than force it to leave empty and return later. Additional parking is more easily achieved at ground-level vertiports, compared to vertiports located on parking structures or tall buildings. These parking needs may drive the overall layout of the facility more than the throughput capacity of the TLOFs.

Computer simulations can identify parking facility requirements based on the type of operations the vertiport expects to serve. Random traffic variability can even examine how busy days will affect the level of service the vertiport provides.

Charging requirements

There have been improvements in battery technology since these vehicles were first conceived, and technical improvements continue to this day. But different vehicles have different charging systems and durations, presenting different infrastructure needs. On some aircraft, depleted batteries can be quickly replaced with charged batteries. In others, the vehicle must be parked for the duration of the charging process. If manufacturers don't agree on a



Simulation is the only way that some aspects, such as charging requirements can be accounted for at the current time

standard charging port or method, then parking positions may have to be duplicated for each charging type.

Without existing data from OEMs, only computer simulations can isolate and model these variables to determine the appropriate number of charging stations based on vehicle type, flight frequency and duration, and recharging capabilities.

Time to start planning for vertiports

Recent studies have highlighted the need to address the infrastructure challenges facing the eVTOL and UAM industry.

Though eVTOL aircraft are not yet certified, and may not be for two years, now is the time to start planning for the resources that will be needed. In the next few years, communities will be forced to address these infrastructure requirements. New facilities will include charging stations, new passenger terminals, aircraft parking, and vertical takeoff and landing areas suitable for these vehicles. These facilities and processes will eventually allow fully autonomous operations for passenger services, package deliveries, and emergency operations by first responders.

Vertiport owners and operators will also have to undergo programs for educating the public, accessing land and airspace, environmental review, and final design of the power needs. These steps can take years before final review, approval, design, and construction can even begin.

Furthermore, until autonomous operations occur planners must examine the interactions between pilots and controllers as these will influence the capacity of the existing air traffic system. These interactions will need to be modeled as part of an assessment of facility requirements and to demonstrate appropriate procedures and policies. AirTOP has tools that support modeling and calibrating controllers' workload due to their interactions with pilots, monitoring traffic, and detecting and resolving conflicts.

The only way to adequately plan for combined operations is by using computer simulations that are capable of modeling various levels of travel demand, measure facility capacities, estimate delays, and visually show these processes to the public and industry stakeholders.

Coordination with existing airports

Regional on-demand air taxi services promise numerous benefits to communities, including environmentally friendly transportation, fewer cars on over-congested roadways, faster local travel options, increased safety and security, and more jobs.

Air carrier airports are expected to receive substantial benefits based on the capital investments airlines have made with aircraft manufacturers. These airlines expect to either offer additional last-mile services, or hope to add the smaller aircraft to their fleets for short-range regional services. Furthermore, vertiports located on or near airports will generate additional revenue through passenger facility charges and other fees. Large communities will be the first to implement UAM services because they offer population demand, have existing road congestion and delays, and have large amounts of disposable income.

For several reasons, vertiports and their associated traffic will frequently be in the proximity of existing airports or on airport property.

First, air carrier airports will be a major source of travel demand for the UAM system. Itinerant travelers don't have their personal cars with them, so a major source of competition for travel mode does not exist for them. Those passengers are forced to choose between rental cars and public transportation.

Second, eVTOL aircraft will use airports for maintenance, recharging, and hangar storage. Even in communities without developed UAM programs, existing airports will be expected to provide these services for itinerant aircraft. Finally, existing airports are the most qualified experts to address security and other aviation issues.

Airport operators will need to plan for the interactions between conventional aircraft which may be large and new eVTOL and eSTOL aircraft, which land at much slower speeds or vertically. Airspace segmentation will be required for vertical and horizontal operations. Ideally, vertiport operations will have minimal impact on the existing airport, but only effective simulations, and replay animations, can truly demonstrate the interactions and their impacts.

"New eVTOL aircraft provide communities with expanded travel options, increased public services, and enhanced safety benefits"

New eVTOL aircraft provide communities with expanded travel options, increased public services, and enhanced safety benefits. Investment in the industry has already exceeded multiple billions of dollars. In the next several years, additional investments will be needed in infrastructure, public education, and acceptance.

The best way to protect these investments is by building efficient and economical systems, minimizing waste, and avoiding delays. Computer modeling will help planners to meet these analytical hurdles and to provide effective tools for demonstrating these operations to the public and industry stakeholders. ❖