IMAGE CREDIT: WOOLPERT

◀ **Whether UAS operate on unplanned or predetermined routes, spatial data is needed to efficiently determine safe paths between their departure and arrival locations.**

THE CHALLENGES OF OPERATING UAM and UAS IN THE LOW-ALTITUDE ENVIRONMENT

The upcoming need for precise, low-altitude airspace mapping will present roadblocks and exciting potential for the UAS and UAM industries

BY ZACHARY SHUMAN

What had been a dream for nearly a century rapidly is becoming a reality. Unmanned aircraft, autonomous package deliveries and urban air mobility (UAM) are progressing at an unprecedented rate.

Theories just a decade ago are now well-articulated business models undergoing conceptual and operational testing. Regulators — federal, state and local — are rushing to keep pace with the research and development efforts of FAA, the National Aeronautics and Space Administration, academia and industry. While the performance and safety of aircraft and associated physical infrastructure are often in the spotlight, there is not a broad and comprehensive understanding or focus on the surface mapping and geospatial data needed to operate these systems.

Unmanned Aircraft Systems (UAS) and UAM operations utilize the dynamic and diverse world of low-altitude airspace. Geospatial data in the form of positional, vertical and obstruction data on the surface within the low-altitude airspace is a critical safety measure for unmanned aircraft and a requirement for autonomous operations for numerous use cases. This data, widely collected in the approach and departure paths of airports, provides key situational awareness and safety redundancies for operators — whether human or artificial intelligence. The emerging UAS and UAM operating models will depend on similarly reliable geospatial data for sites and flightpaths that are not dependent on traditional airports and landing surfaces.

Collection of obstruction data around airports has been regulated by the Code of Federal Regulations Title 14 Part 77

▲ Views like this one from Uber of a proposed eVTOL skyport will be realized in the not-too-distant future. This quickly advancing market requires low-altitude airspace mapping.

for the “Safe, Efficient Use and Preservation of the Navigable Airspace,” and is broadly known by those proposing construction or alteration on structures 200 feet above ground near airports. FAA requires obstruction data for planning and performance of navigation programs and assets, and utilizes Form FAA 7460-1, “Notice of Proposed Construction or Alteration,” to collect this information. The program has built-in infrastructure, support resources, personnel and local situational awareness, in addition to multiple stakeholders’ involvement in the protection of their “imaginary” surfaces and other flight trajectories. This defined process has created a way for federal agencies, state departments of transportation and FAA to identify obstacles that negatively impact navigable airspace.

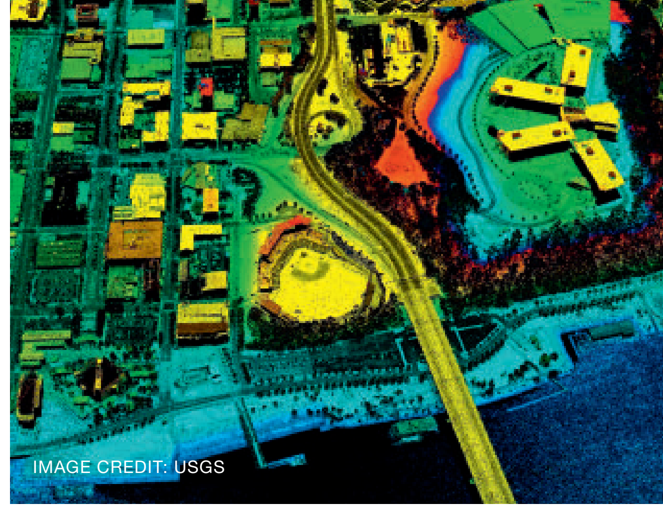
Optionally piloted and unmanned aircraft systems will require significantly more spatial data to safely operate in the National Airspace System (NAS). The aircraft will operate almost entirely in low-altitude airspace, drastically increasing the risk posed by new or temporary structures and creating a hazard to safe and reliable air navigation. Landing areas have not been clearly defined for these systems, yet there is discussion of heliports, converted infrastructure and open areas serving as central hubs for urban air mobility. And package delivery systems’ viability is dependent on the aircraft’s ability to plan for and execute efficient routes at low altitudes without unsafe encounters with obstructions or defined landing areas.

Heliports are likely to be a focus for UAM and large UAS facilities. Operating in the same airspace helicopters currently utilize, with 360-degree approaches, increases risk and the demand for accurate and accessible geospatial data of terrain and vertical features. Currently, heliports are not required to fulfill the stringent requirements under Part 77, and there is little accessible, local obstruction data to support the necessary safety measures. This challenge must be faced before this existing infrastructure can be repurposed, hinting to an opportunity for regulators and industry to collaborate across aviation stakeholders.

Whether UAS operate on unplanned or predetermined routes, spatial data is needed to efficiently determine safe paths between their departure and arrival locations. This generates a need for accurate, current and reliable data that exceeds current storage infrastructure and reporting requirements. On the surface, three challenges are introduced by this need for data: data quality concerns, infrastructure and reporting, and security/governance. These challenges will define policy making, funding, and the regulatory and certification timeline for emerging technologies and industries for years to come.

When discussing any potential capital investment and financial resources, the first question is who bears the responsibility of capturing, certifying the quality and accuracy, and managing the data? For the UAM and UAS industries, that question concerns the geospatial data needed to safely operate unmanned aircraft in low-altitude environments — and that question is harder to answer. Operators can bear that responsibility, but data sharing among competitors is unlikely. Route structures and public use facilities will need to be broadly

▲ **Hyundai was Uber Elevate's first vehicle partner, supporting the company's UAM vision. Emerging UAS and UAM operating models will need reliable geospatial data for sites and flightpaths that are not dependent on traditional airports and landing surfaces.**



▲ **Woolpert uses aerial imagery, lidar, remote sensing and traditional survey methods to generate obstruction and mapping data. This image is from the firm's lidar data collection in Tennessee in 2016 for the U.S. Geological Survey's 3D Elevation Program.**

shared with all NAS users to ensure safety.

Cities, counties and states will play a role in the data collection, but the standardization of data and its reporting function can create challenges for interstate route planning and operator understanding. FAA will be heavily involved, yet its ability to collect and maintain nationwide data of this scale has not been congressionally mandated and may be limiting to the industry's timeline.

The answer also must account for equitable access to the data. Hobbyists, small businesses, helicopter operators, new industry entrants and public services all may need this data to operate in the low-altitude environment. Many will not have the resources to collect, process and interpret the massive amount of data required. Having and utilizing obstruction data in flight planning likely will be a prerequisite to operating at this altitude, even as a redundancy to positively controlled operations and on-board detect and avoid systems.

The data for low-altitude environments, especially in dense urban areas, also must be kept current and sustained indefinitely. Temporary obstructions, including construction cranes and those installed in emergency situations, will need to be captured and communicated efficiently in near-real time to track the introduction and departure of the obstruction. This need adds a layer of responsibility for data collection stakeholders and likely will involve the public and tangential organizations, techniques such as crowdsourcing, and continuously updated electro-optical scanning from equipped operators to enable stakeholders to compile valuable spatial data.

The U.S. covers over 3.5 million square miles of land mass. Data likely won't be collected over the entire country and, regardless, the capacity and resources to store and manage this amount of data currently does not exist. The storage mechanism must be developed that will easily report, visualize and disseminate information to operators. This task is difficult, as it likely will need to ingest data originating from varying formats and sources but can be governed by data compliance standards and delivery systems.

Defining policy and requirements and publishing an acceptable data standard for equitable storing and sharing is the largest planning and policy effort that needs to take place before the unmanned industry is cleared to fly. This database of geospatial data, which can be updated consistently from numerous data collectors and through a mesh of crowdsourced and operator derived information, will require significant management and security measures. These safety-critical data will guide both flight planning and route planning, which the industry may implement in dense urban centers.

FAA's current obstacle database has more than 495,000 obstacles. While this database may have the foundation to support a low-altitude mapping interface, there is still work to be done to create that expanded infrastructure to store vastly more data. In this new environment, aeronautical charts and flight routes will need to be created and updated in near real time or supported by an enhanced eNOTAM-like system. This can be done by utilizing current aeronautical chart data, such as maximum elevation figure (MEF), to electronically determine when and for how long a specific area needs to have a higher low-altitude floor.

Once the policy and infrastructure groundwork are laid, the data must be collected. For this amount of data, universal country-wide mapping is unlikely. Instead, the utilization of complementary data-capture efforts and existing data from sources such as statewide imagery and lidar programs, federal imagery programs, UAS and UAM operators, FAA geospatial databases (like the FAA Aeronautical Data

Information Portal) and the airport obstruction database will be necessary. Existing data will need to be validated and supplemented with data collection.

Better communication can greatly increase the efficiency and cost savings of large-scale data collection efforts. Airport, cities, states and federal agencies all need a forum to share collected data. While this sharing of data does decrease the risk of a duplicate collection effort, it also heightens the need for verification, validation and the creation of data standards to ensure natural features are collected — like for trees with leaves on rather than leaf-off conditions.

The data needed can take many forms and collection methods. Woolpert has used aerial imagery, lidar, remote sensing and traditional survey methods to generate obstruction and mapping data. For smaller collections and validation efforts, UAS is efficient and cost-effective. Paralleling the various data collection opportunities for capturing this level of safety critical data, there will be opportunities for UAS and UAM vehicles to capture additional near-real-time updates.

The challenge of formalizing and standardizing data capture does present a roadblock for the success of the UAS and UAM industries, but it also presents unprecedented opportunities to create a safer and more aware aviation community, as well as commerce opportunities that benefit our citizens. The data collected will assist UAS and UAM operators, traditional and emerging optionally piloted and unmanned helicopter pilots and the planning community and provide them with tangential benefits. The solutions to these challenges will be created through strong collaboration with regulators, aircraft manufacturers, consultants and operators.

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