cross sections

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TECHNOLOGY
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HIGH HOPES: DRONE INSPECTIONS FOR BUILDINGS AND STRUCTURES

Imagine arriving on site for an inspection of a high-rise office building. You take your drone out of a backpack, power it up, and set it on the sidewalk. Back in the office, you programmed the flight path as well as camera positions for still photographs and video. Now, you simply tap an icon in your smartphone's drone app and the drone takes off, flies its mission, and returns to land itself at the takeoff point.

Kristen Olson, Vertical Access LLC

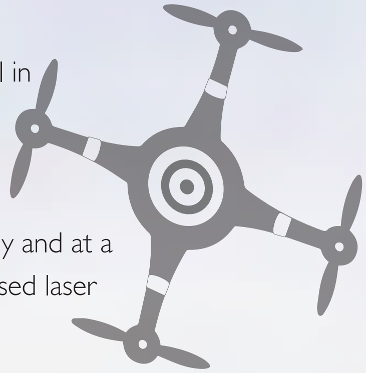

VA DRONE PILOTS ON SITE DURING A RECENT PROJECT

There has been great interest in the engineering and construction applications of unmanned aerial vehicles (UAVs), also known as unmanned aerial systems (UAS), small unmanned aircraft (sUA), or simply drones. UAVs have already gained widespread acceptance, if not widespread implementation, for agriculture, site surveys, energy infrastructure inspection, and construction monitoring, not to mention real estate and film production. But what role will they play in inspecting and diagnosing buildings and structures, especially in dense urban areas? Will engineers and consultants soon be spending more time behind the controls of a drone (or behind the screen of a smartphone's drone flight app) than on scaffolds and swing stages?

PROMISING TECHNOLOGIES

In 2016, Gartner Inc. placed commercial UAVs close to the "peak of inflated expectations" position on its annual Hype Cycle for Emerging Technologies. In reality, commercial applications are wide-ranging, with some uses already proven (monitoring crop health), and others still years away from implementation (drone deliveries). A UAV by itself is ultimately just an operating platform, and it's important to remember that many of the anticipated applications of drones will depend upon the advancement of software innovations and other technologies that are themselves in various stages of development, such as automated crack detection, 3D photogrammetry, and virtual reality, to name just a few.

There are some tasks drones won't be taking over just yet, like conducting nondestructive evaluation or opening probes in a façade. Still, there are several useful drone applications for the inspection of buildings and structures. Where pinnacles, finials, and cupolas are impossible to access without building a frame scaffold, drones can provide a quick and relatively inexpensive yet hands-off inspection. In municipalities with façade inspection ordinances, drones may provide a "first pass" to help identify areas for a more thorough, hands-on investigation using suspended scaffolding or other means. For projects where rope access presents the fastest, least intrusive, or most economical option, a reconnaissance flight by a drone can be a first step in developing a rigging plan, or it can be a physical rigging aid, flying a lightweight line up and over a building element, in order to help install heavier rigging for personnel. Drones are also an obvious match for infrared investigations of tall structures, where the angle of view is crucial in obtaining useable data. And, drone-based photogrammetry presents opportunities to model buildings and structures accurately and at a fraction of the cost of ground-based laser scanning.



But before engineers, architects, and consultants can get their drone services off the ground, they have to figure out how to fly legally.

THE CURRENT STATE OF DRONE REGULATIONS

In August 2016, 14 CFR Part 107 went into effect, providing a framework for the legal use of drones for commercial purposes. Prior to 107, companies had to undergo a lengthy and cumbersome process of obtaining a "Section 333" exemption, and even then, the rules were so restrictive as to effectively prohibit drone flights in all but the most remote locations.

Now commercial operators can fly in unrestricted airspace up to 400 feet above ground level (higher if the UAV remains within 400 feet laterally of a building or other structure) and in populated areas, as long as they comply with a host of rules, including a prohibition against flying over people. All drone operations must be under the direction of Remote Pilots who must pass a written test and a TSA background check.

Exemptions can be requested for several of the Part 107 rules, many of which are likely not of concern for engineers (no operating your drone from a moving vehicle or at more than 100 miles per hour, for instance). However, consultants wishing to conduct infrared investigations outside of daylight hours will need to apply for an exemption to the daytime operation rule.

While Part 107 represents a big step in the right direction, a significant hurdle for building and structure consultants remains, in that many urban areas are within restricted airspace, generally around airports, where commercial drone flights require special permission from the FAA. For example, the snowman-shaped Class B airspace of LaGuardia and JFK airports covers all of Manhattan north of midtown, nearly all of Queens and the Bronx, and about half of Brooklyn. Most of the Buffalo, Rochester, Syracuse, and Albany metro areas are in Class C restricted airspace; Ithaca, Rome, Newburgh, and White Plains are largely in Class D airspace; and about half of Long Island is in either Class C or Class D airspace (Class B airspace surrounds the nation's busiest airports, while Class C and D airspace typically extends two or more miles from smaller and regional airports).

To fly in restricted airspace, remote pilots must request an airspace authorization or airspace waiver from the FAA at least 90 days in advance. As of November 2017, according to the FAA, "there is a backlog of Airspace Authorizations of 3 months and Airspace Waivers for 6 to 9 months." This timeframe places a significant burden on operators whose project schedules don't accommodate a 3-month wait, and the uncertainty of whether a request will be granted dampens the marketability of drone services. The authorization process is expected to become much more streamlined within the year as the FAA rolls out a platform for "real time" airspace authorizations based on maps of pre-authorized areas, called the Low Altitude Authorization and Notification Capability (LAANC). This is expected to be a temporary bridge to a system that NASA is developing called the Unmanned Aerial Vehicle Traffic Management System (UTM), which has a target date of 2019. This next-generation system will be necessary for businesses to realize the types of drone services that are grabbing headlines, such as package delivery.

If the status of FAA regulations isn't complicated enough, states, municipalities, and government entities such as the National Park Service are making their own rules, which may be more restrictive than the FAA's rules. The legality of these "patchwork" regulations has not yet been tested in court, and in fact there is legal precedent for a single set of rules under the sole authority of the FAA. Also contributing to uncertainty about commercial operations is the fact that the readiness of local law enforcement to handle issues related to commercial drones is largely untested.

CASE STUDY: INVESTIGATING A DECOMMISSIONED POWER PLANT

Our firm recently conducted a drone inspection of areas of the Glenwood Power Plant on the Hudson River in Yonkers, New York, working for the Lela Goren Group as part of a project team including Easton Architects and Silman. The plant is located in Class G (unrestricted) airspace, so no burdensome authorization process was required, allowing our team to mobilize in a timely manner. The drone inspection complemented a hands-on investigation of the structure performed by Vertical Access as well as other members of the project team, providing video footage of areas of the structure that were unsafe for personnel access. VA conducted the drone inspection in advance of the hands-on investigation, in order to determine which areas of the structure would be safe for personnel access.

VA'S DRONE HOVERS TO THE RIGHT OF ONE OF THE SMOKESTACKS

The plant was constructed between 1904 and 1906 and was designed by Charles Reed and Allen Stem as one of two plants to serve the New York Central Railroad electrification. The steel-framed, skylit brick building is partially supported over the Hudson by timber piles. The complex consists of a three-story switch house, turbine hall and boiler room, pump house, and coal bunkers. Two raised chimney stacks extend through the roof of the boiler room. The plant closed in 1963, and in 2008 it was listed on the Preservation League of New York State's annual "Seven to Save" list of endangered properties. It is scheduled to undergo rehabilitation into a mixed-use arts and events center.

Vertical Access was tasked with performing a drone survey of the chimney exteriors and portions of the south and west facades, in addition to hands-on investigation and access to other areas of the structure. VA used a DJI Phantom 4 Pro quadcopter to record video of both smokestacks, saving hours of rigging and climbing while providing a much safer means of access for observing the condition of the brick masonry. The UAV survey also provided views of the power plant facades that are visible only from the river. Combined with hands-on survey of other areas of the building, including measurements of structural steel framing, the data gathered by the drone will help the project team with the assessment of conditions and preparation of construction documents as part of the larger rehabilitation effort.

VIDEO STILL CAPTURED BY VA'S DRONE OF ONE OF THE GLENWOOD POWER PLANT SMOKESTACKS

CONCLUSIONS

While drones present great opportunities for engineers and other building consultants, implementation has been hampered by uncertainty about regulations and local ordinances, airspace restrictions that disproportionately affect urban areas, and the limitations of current technologies. As of this writing, there is not yet an out-of-the-box solution to bring to life the scenario described in the opening paragraph of this article. Today's drones still require skill and practice to fly safely, but features such as sense-and-avoid capabilities are inching drones closer to full autonomy. As demonstrated in the case study, successful operations will combine clear benefits to the project team, the ability to gather quality data, and a cost or time savings over other means of access. Most importantly, drone inspections will be in addition to, not in place of, hands-on investigation and other evaluation methods.

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