

Drones in Practice

Changing the Way Engineers Work

By Zane Pucylowski and Chad Conley

Engineers are constantly trying to find new ways to optimize processes to perform their duties more effectively. Implementing drone or Unmanned Aerial Vehicle (UAV) technology in their projects is one solution engineers have found over the past few years and are starting to use.

Drones used in engineering are a great way to enhance practices, cut costs, streamline processes, and increase efficiency. These UAVs are valuable tools in many ways, giving engineers a multi-dimensional utility across the specialties.

Improving Infrastructure

Managing physical assets is a key component of using drones in the field. Engineers piloting a drone can perform manual inspections and site surveys without being on-site. Drones with additional features like live stream capabilities allow engineers, project managers, developers, and superintendents to stay fully informed when working off-site.

Programs can be downloaded to provide access to multiple individuals working on any given project. These programs allow pilots to fly the drone over the worksite and tag issues for workers and contractors to assign tasks. In turn, these workers can comment back on the viewing application in real time with the team.

Inspecting work sites with a drone ensures workers can be proactive in building or improving infrastructure and help prevent deterioration. For instance, a drone equipped with a thermal camera can identify areas strained by weather or leaks. These cameras instantly visualize temperature ranges throughout the structure and allow engineers to see damage that might otherwise go unnoticed, allowing workers to fix the issue before it becomes dangerous.

Improving Workflow

Drones can save a significant amount of time when replacing existing processes. For example, engineering firms can save time and money by doing site measurements once, then using digital models created from the information provided by the drone instead of making repeated trips to the site.

Many engineering firms have traditionally used helicopters to get aerials on a project.

However, these flights can cost anywhere from a few thousand dollars to \$20,000 per flight to capture the videos necessary to map the project. Today, drones at a fraction of the price provide engineers with the videos they need and data on topography, heat signatures, and water levels. In addition, new technology is constantly improving workflow, such as photogrammetry, creating marketing material, and site monitoring.

Adding drones to an engineering firm's arsenal of tools boosts the productivity of those working on the project and provides the information needed to keep the project on track.

Mapping Job Sites

Innovations in drone software allow engineers to produce detailed 3-D maps and models using the data the drone captures. This accurate site data can cut costs because the visualizations help teams plan their activities and reduce the risk of design errors that may require reworking. For example, when engineers work on a new job site where the ground has yet to be broken, drones can fly over the area and capture the terrain. This mapping allows engineers to know where to focus leveling, locate flood basins, and anticipate any difficult-to-dig material below the surface, thus saving time and money. All engineers need to do is place ground control points throughout the site and fly the drones. The drones capture the area, and the engineers can inspect the topographic surveys.

The 3-D maps that drones create can be combined with an analytics platform allowing engineers to communicate the data to the entire team. Improved digital mapping also means every team member is aware of the site's landscape and is working with the same information. Instead of taking days or even weeks to walk the site, engineers can fly the drone to provide a field-to-finish solution for the mapping process.

Structural Engineering Benefits

Structural engineers often use drones to inspect those hard-to-reach places. Engineers use UAVs to collect photos, enabling a precise assessment of the existing conditions of skylights, roofs, bridges, and culverts.



Structural engineers find drones to be very beneficial in documenting existing conditions of areas like bridges. For example, if there is a need to scan a bridge, drones not only create an accurate representation of the bridge but also shorten the time it usually takes.

Another area that drones are beneficial for is when surveying a property, especially if the terrain is rough. Using a drone requires no boots on the ground walking through hazardous locations. Instead, the drone operator can mark points, create a 3-D model of the area, and share that data with the engineering team using point cloud technology.

Keeping Track of Progress

Staying on time and under budget is vital to the success of any engineering firm. All projects need to operate on a timeline, and engineers are tasked with ensuring the timeline is kept.

Drone flyovers show the progression of the project site. Engineers can compare the initial map of the site with an up-to-date flyover of the site. Comparing these different photos and videos gives engineers insight into what has been done on the site, what needs to be done, and what areas may need additional work. In addition, these images help engineers monitor the project and ensure the schedule is kept. It also reduces the time engineers need to spend on the job site.

Cameras and Sensors

Engineers can attach cameras and sensors to drones, including optical gas imaging to detect gas leaks and multispectral imaging sensors to study land usage.

Light detection and range (LiDAR) scanners are among the most popular attachments for engineers. LiDAR captures hundreds of square miles a day. These scanners measure

up to 80 separate points per square meter, creating a very detailed digital model of a landscape. The accuracy of LiDAR allows the scans to be used in 3-D models in all aspects of design, planning, and decision-making. LiDAR sensors can also see through dense areas to capture the earth's structure that even satellites cannot see.

Photogrammetry cameras make it possible to record objects with more than one image. This allows for 3-D reconstruction, where the shape and position of an object are taken by measurements in the image. The reconstruction occurs through a non-contact recording, image interpretation, and model evaluation.

Richer Results

5G wireless networks are being built across the country and the world. Drones with 5G capabilities are coming to the market quickly, and this new technology allows for new capabilities. Virtual reality usage with drones is a crucial area that benefits from this new form of data transfer. An engineer connected to a virtual reality setup can be miles away in the office controlling the drone at the work site. They only need someone to take the drone outside and turn it on. Once it is up and running, the engineer back at the office has complete control of the drone to do whatever task is needed.

The main benefits of 5G-capable drones include low latency, rapid data transfer, real-time analytics during flight, and up to a million connected devices per square kilometer for easy communication with multiple people.

Sharing the Data

Visual communication helps engineering teams stay up to date on projects which is critical for success. Many engineering projects have multiple shareholders and companies working together to achieve one goal. Whether a private or government contract, engineers want to stay connected with off-site workers and other leaders on the project. Drones simplify sharing data collected on a project with all parties.

Sending handwritten updates is now a thing of the past. Drone imaging provides comprehensive details to all those involved. Many people associated with the project are often too busy or far away to make regular trips to the site, so having a drone to provide aerial data, maps, and videos makes communication much more effortless.

Each image or video shared includes metadata for easy documentation. This data allows the organization and access to specific points that an engineer needs to find quickly. For instance, each time the drone records during

a flight, it creates a file that metadata can search. These files can be searched by time, date, and other information. Most commercial drones have high-end software allowing engineers to include the information they need in the metadata.

Drones are also an excellent way for project leaders to provide team members with information. For example, rather than getting on a call and telling the on-site workers where the issues are, they can provide visual data from the drone footage to communicate a problem that needs addressing.

Easily shareable data is essential in keeping projects on task and everyone in the know about what is happening on-site. Drones make this process easier and more accessible for all of those involved.

Maintaining Site Safety

According to the Occupational Safety and Health Administration (OSHA), falls were the number one cause of injury and death in the construction industry in 2019. Engineering and construction companies are understandably concerned with any injuries occurring on job sites and are always looking for ways to minimize these risks.

Flying a drone removes the danger of having people climb high structures or needing helicopters to survey the worksite. Drones can survey dangerous areas and take engineers and other workers out of the high-risk areas where these injuries typically occur.

Drones are piloted from a distance and often away from the work site, which is essential when working in areas too dangerous for people. For example, many factories have hazardous or flammable materials that workers should not encounter. Instead of sending out engineers to work in these areas, drone operators can stay at a safe distance while the drone flies over the area to collect data. This saves the engineering firm time and money and minimizes the risks to the workers.

Drones also reach heights not available to humans climbing the structures. Drones can reach the optimal vantage point of a project and provide detailed inspection records and safer environments for workers.

Reducing Workers' Compensation Claims

According to OSHA, employers pay almost \$1 billion weekly for workers' compensation costs. This outlay includes payments, medical expenses, and legal services. In addition, there are many indirect costs the employer must pay, including training replacement employees, lost productivity, lower employee morale, repairs, and accident investigation.

As mentioned previously, drones can help improve worker safety. Improving worker safety decreases the frequency of on-site incidents and saves engineering firms and construction companies from paying high workers' compensation costs.

Licensing and Laws

Flying a drone for commercial use in the United States requires a Remote Pilot Certificate from the Federal Aviation Administration (FAA). Operators applying for a certificate must be able to read, speak, and write in English, be in a mental and physical condition to fly the drone safely, and be at least 16 years old. Operators must also pass an Aeronautical Knowledge test at an FAA-approved testing center and undergo a security screening through the Transportation Safety Administration.

Laws for operating drones vary by state, so it is essential to contact the state's Department of Transportation to ensure compliance.

The increased use of drones correlates with an increase in possible property damage, bodily injury, and other liability issues. However, the FAA lacks protections for liability caused by drones. For example, there are no regulations regarding whether a commercial company, a pilot, or a drone manufacturing company is liable when a drone crashes.

There are many laws regulating the commercial use of drones. It is best to speak with your insurance agency and the state's Department of Transportation beforehand to ensure the drone is being used properly.

Utilizing drone technology for engineering projects can ensure that projects remain under budget and on time. Drone data helps reduce the hours spent on time-consuming tasks like inspections and expedites daily processes. By allocating labor and resources to the most critical assignments, engineers can prioritize their duties and create an efficient working environment. Engineers equipped with the latest technology, like drones, can make better-informed decisions for their firms and the job at hand. ■



Zane Pucylowski is the President and Principal Engineer at Phoenix Engineering and Consulting, Inc. in Woodstock, Georgia. He is also a part-time faculty member teaching senior design in the Mechatronic Engineering department at Kennesaw State University.

Chad Conley is the CEO of Complete Roofing in Woodstock, Georgia. Conley is certified by the FAA as a Commercial Drone Operator and has a private pilot's license through the FAA.