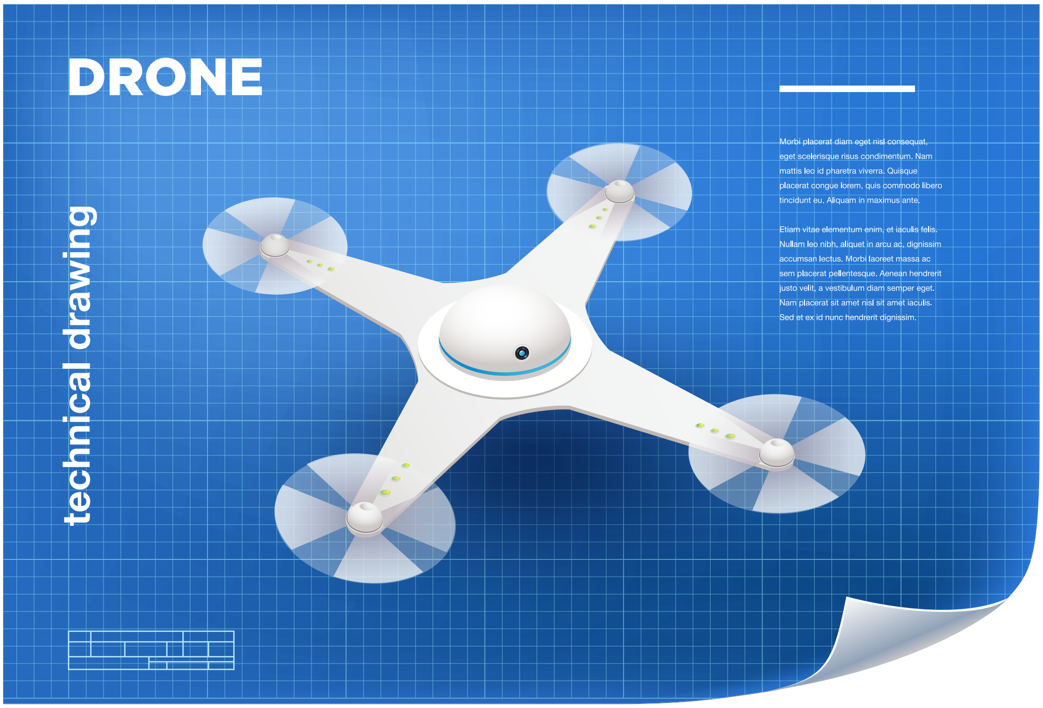
UAS Maintenance: The Same, but Different

By Brad Hayden



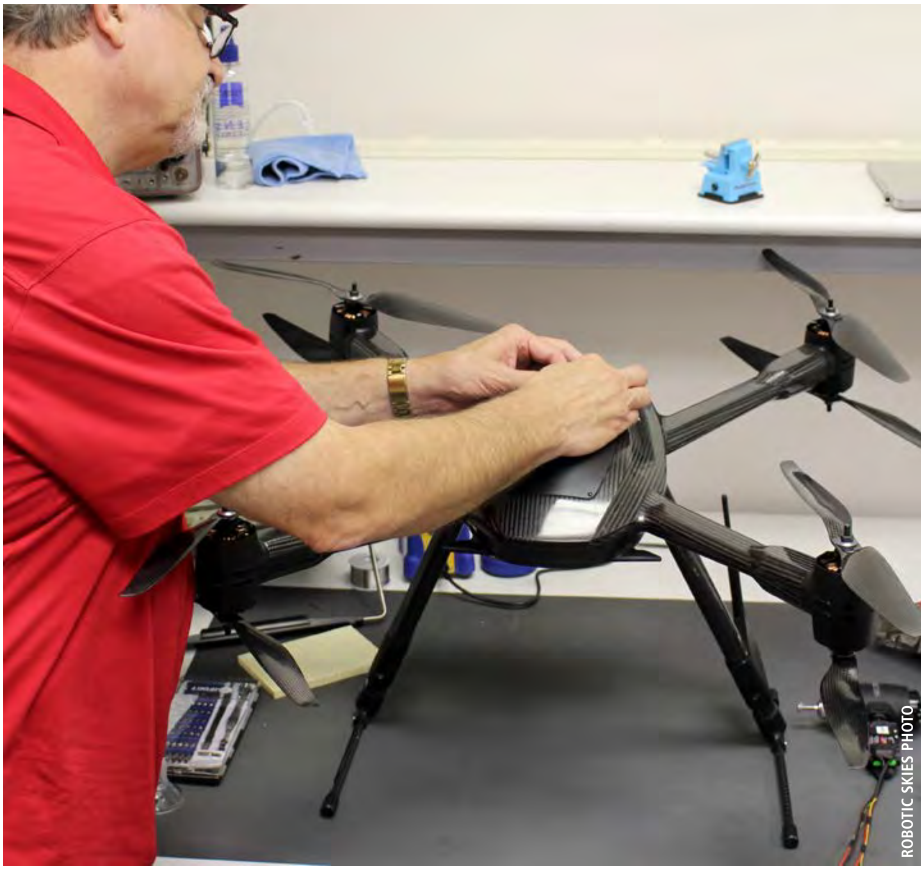
When talking about unmanned aircraft systems (UAS), or drones, one should remember that the terms can refer to small multirotor systems — like the inescapable DJI Phantoms — to large, fixed-wing aircraft that require long runways to take off and land. What these hobby craft, military systems, and commercial-grade industrial platforms have in common is that they are a form of aircraft.

Over the years, commercial aviation has developed an enviable, although by no means perfect, safety record. This was accomplished in part by making safety assurance a dominant factor in aircraft certification, including the development of standardized maintenance procedures and processes designed to deliver reliable performance.

Like manned aircraft, we use UAS for entertainment, transportation, commerce, and national defense. In fact, I think of this emerging technology as a new market segment of aviation, rather than an entirely new industry. For those of us already engaged in the business of operating aircraft for commerce, we'll need to apply the existing safety-based paradigms of manned flight, which have served us well over the last century, to this new breed of aircraft.

Similarities in UAS Maintenance

When it comes to maintenance and inspections, the only real difference between commercial-grade UAS and manned aircraft is where the pilot sits. In all aircraft, "things break," says Jonathan Daniels, president of Praxis Aerospace Concepts International,



Robotic Skies maintenance technician performs a final inspection on a commercial UAS.

who was a helicopter pilot for roughly half of his 24-year military career and spent the second half directing UAS units for the U.S. Army and NATO.

"Preventive maintenance and continued airworthiness inspections are even more important in drones because there is no pilot on board to monitor the systems for in-flight failures and to address them before they lead to an unhappy conclusion to the flight," Daniels says. "Without an onboard pilot's sense of something about to go wrong, you need to know as much as possible about an unmanned aircraft's condition before it gets in the air."

Fleet operators considering the addition of commercial UAS should disabuse themselves of the notion of disposable drone craft for both economic and professional reasons. Unlike the ubiquitous hobby drones on the market, commercial UAS are not disposable toys. UAS are full-fledged aircraft that deserve the same level of care given to manned aircraft.

While it's true that UAS are less

expensive than a manned aircraft, the more capable drones are still not cheap. When you add in the cost of a high-end camera, you could easily end up with a six-figure aircraft. Additionally, operators who maintain UAS to lesser standards risk instituting a sense of complacency that can infect the rest of the operation, both manned and unmanned alike.

As with the other aircraft in an operator's fleet, unmanned aircraft have airframe structures, powerplants, and avionics systems that must perform reliably, often in trying environments. This commonality with manned aircraft components makes it easier for helicopter operators to integrate UAS into their aviation safety culture and ultimately will give them an advantage over other operators without an aviation background.

The bottom line is that professional fleet operators understand that well-maintained, reliable drones that are flying missions are much more profitable than drones that are not. And just like in manned aviation, maintenance is the key to delivering that reliability.

Additional Issues in UAS Maintenance

While UAS have many similarities to manned aircraft, it's also important to remember that they have differences as well. For example, drones have an additional system critical to flight: the control station, or the drone's "cockpit," which is connected to the aircraft by a line-of-sight radio datalink.

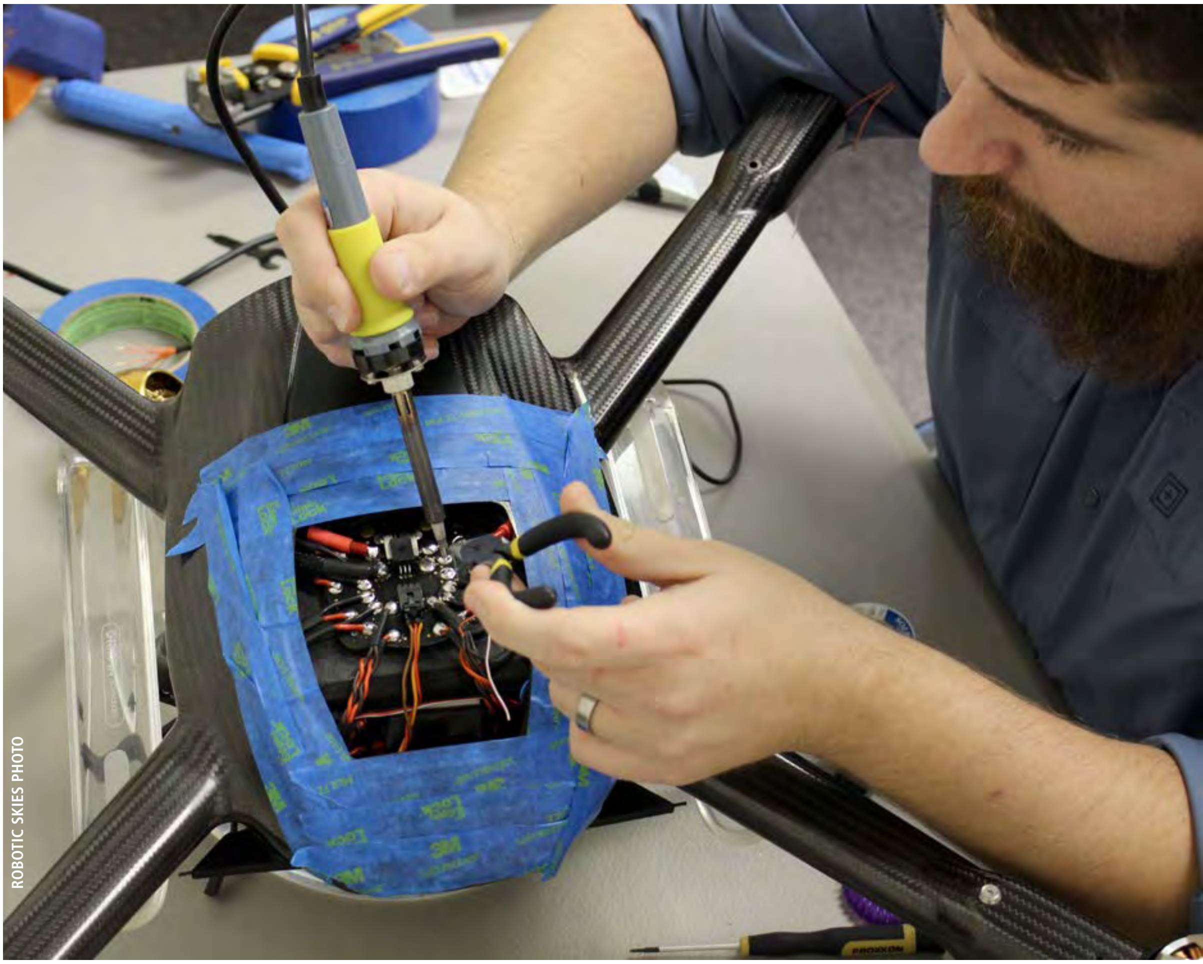
While by definition, a UAS has no flight crew aboard, depending on the mission you may need ground crewmembers such as a spotter who is the drone's see-and-avoid observer, and a systems operator, who might control the gimbal-mounted camera. Both observers must be able to communicate with the UAS pilot in command through a reliable communications network.

UAS rely on computer platforms to control every aspect of their performance, and manufacturers often issue software and firmware upgrades. This adds another layer of maintenance, and just like preflight checks on manned aircraft, a UAS shouldn't fly until every aspect of its onboard processing, communications, and flight control systems are 100 percent operational. If you know the safety protocols that work for manned helicopters, why change that paradigm for drones?

Adding to UAS complexity are the advanced stabilization and geolocation systems that make them so easy to fly. They employ technology that is a step beyond the stability augmentation systems, autopilots, and flight management systems now employed in manned helicopters. Because each manufacturer addresses these enhanced capabilities differently, common failure modes and behaviors are not guaranteed.

For example, what the UAS does when its command signals are lost with the ground station is not consistent across platforms: some hover, some fall to the ground, and others return to their launch location. Operators should spend time familiarizing themselves with the UAS manuals' content on lost signals and other equipment failure annunciations and protocols (if such documentation exists), and should even consider practicing these emergencies under controlled conditions with an instructor.

When a computer displays the "blue screen of death," it's annoying because you have to reboot before you can resume your work. But that same incident can be disastrous when it happens to a UAS in flight, especially when it is carrying a $35,000 camera. This is exactly why operators that are currently permitted to fly commercial drone missions are restricted to line-of-sight operations over unpopulated areas.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In-depth experience in avionics is required to troubleshoot, maintain, and repair the computer-based UAS systems.

Until the FAA works its way through the notice of proposed rulemaking (NPRM) regarding the operation of small UAS, operators may only use them commercially after earning the exemption described in Section 333 of the 2012 FAA authorization. The exemptions contain conditions and limitations on drone operations, such as limiting the altitude or speed and requiring that the UAS be operated within the line of sight of the pilot in command and an observer. However, at this time, there are no regulatory requirements for UAS maintenance, either scheduled or on-condition.

As a manned and unmanned aviation maintenance professional, initially I was taken aback by the NPRM's position that no airworthiness or ongoing inspections by a certificated technician would be required for commercial operations. The FAA's reasoning on this matter is that the "current processes for issuing airworthiness and airman certificates were designed to be used for manned aircraft and do not take into account the considerations associated with civil small UAS."

The NPRM goes on to say that obtaining a type certificate and a standard airworthiness certificate currently takes about three to five years, and that "it is not practically feasible for many small UAS manufacturers to go through the certification process required of manned aircraft … because small UAS technology is rapidly evolving at this time, and consequently … the small UAS would be technologically outdated by the time it completed the certification process."

This reasonable stance taken by the FAA will allow this developing industry the flexibility to reach its potential without the constraints of onerous certification and maintenance processes that address safety concerns that simply do not exist for these small unmanned aircraft.

This is good news for us in unmanned aviation maintenance. More permissive regulations lead to more UAS flying commercial missions. And the more UAS that are flying, the more maintenance they will require to stay airborne and profitable for their operators.

Building a UAS Maintenance Knowledge Base

Given the similarities of UAS components to manned helicopters, integrating the established template of maintenance and inspections into UAS maintenance sounds relatively simple. And it would be if UAS manufacturers provided operational and maintenance documentation developed during the FAA type certification process.

But drones are not certificated, so manufacturers provide documentation of varied depth and detail, from a few pages to booklets written in the language of technology, not aviation.

The lack of documentation for drones is the biggest issue in UAS maintenance, particularly for those of us accustomed to working on FAA-certificated aircraft. Because drones are not certificated by the FAA, they do not come with maintenance manuals that describe in complete detail what a part does, what it looks like, how it might typically fail or wear, how to maintain it, and at what intervals.

Still, a background in aviation maintenance comes in handy. When working on UAS that are unmanned models of traditional helicopters, maintenance crews can draw on "seven decades of tribal knowledge," said Daniels. "Multirotor drones use the same sort of systems, but some are hybrid-powered lift aircraft, and outside of the military, this is new territory. With a knowledge base that is barely a decade deep, we can't rely on the manned powered-lift world to tell us what 'right' looks like."

When adding a certificated helicopter to the fleet, it comes with maintenance and continued airworthiness documentation that includes a schedule of periodic inspections and time-limited components. Operators should not expect this critical information from a UAS manufacturer, many of whom come from a technology, rather than aviation, background. Instead, UAS commercial operators will have to develop their own schedules and component life-limits through pre- and post-flight inspections, and document every detail.

Many UAS make up for their lack of documentation because, as computer-based systems, operators can download, store, and analyze the data they record during every flight. Using this flight data, operators can see the data that pertains to failures and ascertain solutions. In some regards, the data recorded during the flight is comparable to the automatic error messages Windows compiles during a failure, except the drone doesn't automatically send that data to the manufacturer.

Currently, there are no FAA requirements for keeping or tracking UAS maintenance records. But operators should be vigilant from the start for the same traceability and accountability reasons that they keep maintenance records on their manned aircraft.

In the absence of FAA standards, the operator's maintenance records will form a UAS maintenance knowledge base. In time, that knowledge base will become standardized, repeatable maintenance processes and procedures. If UAS operators build a documentable record of safe operations, this data will support the next step, which is fully certificated UAS that can operate beyond the operator's unaided line of sight, above 400 feet, and with their manned aircraft cousins in the National Airspace System.

Ultimately, maintenance of manned or unmanned aircraft comes down to the people who make it happen. My firm, Robotic Skies, is working with Part 145 avionics repair stations around the world to establish a UAS maintenance network. Our experience has proven that their technicians' skills are directly transferable to unmanned aircraft systems. The often-missing ingredient, however, is in-depth experience with digital avionics, because drones' effectiveness and reliability depends on network connectivity.

Riding the Learning Curve

We're building a new market, and like anything new, there's a learning curve. Praxis Aerospace's Daniels cites the example of when night-vision goggles expanded beyond the military and went to work in the civilian market. "We didn't give pilots a set of goggles and say, 'Go,'" he says. "We had to train the pilots and modify the cockpit, its lighting, and glass so they could see outside. We didn't change everything; we just made the changes necessary to integrate the new technology."

It's no different when operators add drones to their maintenance operations. They shouldn't create a set of lesser standards for UAS inspection and maintenance, nor should they go overboard and rebuild the drone after every flight. Rather, savvy operators will apply their existing inspection and maintenance procedures as needed to the drone so the result is the same level of reliability and safety delivered by their fleet's manned aircraft. R

Brad Hayden is president and CEO of Robotic Skies, a worldwide network of more than 80 air agency–approved repair stations that are optimized to provide UAS inspections and maintenance. A certificated private pilot and an avid first-person-view drone pilot, Hayden believes that the future of aviation lies in embracing and supporting emerging technologies, such as unmanned aircraft, as they enter the mainstream of the civilian aerospace industry. For more information, visit RoboticSkies.com.