

The Future of Unmanned Aircraft Systems:

Is There a Niche in Aerial Application?

By Danna Kelemen



Ever since the Wright Brothers first achieved flight a century ago, humans have been fascinated with aviation. Hundreds of years earlier the visionary Leonardo da Vinci attributed flying to an experience unlike any other: “Once you have tasted flight, you will forever walk the earth with your eyes turned skyward, for there you have been, and there you will always long to return.” As we progress into the 21st century and the amount of general aviation aircraft worldwide numbers upward of 350,000, it’s not surprising the airspace continues to become more and more congested. By 2015, the U.S. airspace is projected to become even more crowded as the marvels of unmanned aircraft transform from fantasy into reality. As commanders of the original “low and fast” flight, ag aviators have reason to be wary about what this new type of revolutionary aircraft will mean for the aerial application industry in terms of safety and vying for low-level airspace.



Up until recently the guidelines for flying anything unmanned were pretty simple: adhere to the FAA’s advisory circular (AC) for model aircraft operating standards and above all else stay out of the way of full-scale aircraft in flight. When the FAA issued AC 91-57 some 32 years ago it was in an effort to create safety standards for model aircraft operators and reduce the potential for accidents with manned aircraft. Back then, unmanned aircraft were certainly being discussed, but more in terms of drone use for the military. In fact, an unclassified digest report from the Comptroller General’s Office in 1982 stated, “The Army’s remotely piloted vehicle shows good potential but faces a lengthy development program.” Little did the U.S. government know just how quickly this development would take place, and as a result the regulatory and accountability issues we are now facing today. With the passage of the 2012 FAA Reauthorization Bill, unmanned aircraft systems (UAS) are coming, and they’re coming quickly. As an industry we must determine the best practices for sharing the national airspace while proactively safeguarding low-level aviation.

A 2007 FAA Notice defines unmanned aircraft as a device that

is used, or intended to be used, for flight in the air with no onboard pilot. Their complexity, size, method of control and intended use may vary greatly, but the FAA currently classifies unmanned aircraft into three distinct categories: public aircraft, civil aircraft and model aircraft. According to a July 2011 FAA UAS Fact Sheet, there are approximately 50 companies, universities and government organizations currently developing and producing more than 155 unmanned aircraft designs. Beyond use as recreational vehicles by model airplane users, the only two acceptable (and legal) means of operating UAS in the National Airspace System (NAS) outside of “restricted” airspace are through Special Airworthiness Certificates in the Experimental Category (SAC-EC) or Certificates of Waiver or Authorization (COA). Experimental aircraft are certifiable via SAC-EC only and while precluded from carrying persons or property for payment or hire, experimental aircraft are approved for research and development, market survey and crew training. However, in late July the FAA issued its first restricted category type certificates and opened the door for unmanned aircraft being able to be used for surveillance. The Agency stated the approval is “a milestone

that will lead to the first approved commercial UAS operations later this summer.” On the other hand, public aircraft must go through the COA process should they wish to be flown in civil airspace. This includes aircraft used by law enforcement, military and other governmental agencies. Generally speaking, the FAA issues COAs based on the following premises: authorization for an operator to use defined airspace, and includes provisions unique to each individual operation; coordination with the appropriate air traffic control facility and may also require a transponder to operate in certain airspace; and in the absence of sufficient “see and avoid” provisions the requirement for operators to have a visual observer or “chase” aircraft maintaining visual contact with the UAS.

Potential Economic Impact of UAS

If one watches the nightly news or picks up the latest newsmagazine, the topic du jour is UAS and the many potential commercial uses they will likely have in the future. In an NBC *Today* show segment aired on July 8, the news program documented a visit to the Holloman Air Force Base (New Mexico) UAS training Unit and provided a closer look at the Remotely

Piloted Aircraft (RPA) training program. The Air Force predicts the growth for RPA pilots to be exponential and estimates graduating 700 UAS pilots in 2013 alone—many of whom are not traditional military pilots and have never piloted a manned aircraft.

Beyond the military the potential for commercial use has been fueled in aviation circles by a March 2013 Association of Unmanned Vehicles Systems International (AUVSI) report that stated, “While there are multiple uses for UAS in the NAS, this research concludes that precision agriculture and public safety are the most promising commercial and civil markets.” The report further evaluates the economic impact of integration of UAS at \$13.6 billion in the first three years alone and estimates it will create more than 70,000 jobs as well in the same amount of time. These sorts of figures, if accurate, certainly make one stand up and take note of just how influential unmanned aircraft will be in our nation’s airspace in the years to come.

While UAS are currently the up and coming instruments of flight here

in the U.S., they have been used in precision agriculture in Japan for the last 25 years. Since 1987 variations of the original Yamaha R-50 industrial-use unmanned helicopter have been used primarily for seeding and spraying rice, but also in remote sensing, precision agriculture, frost mitigation and variable rate dispersal. Today, there are about 2,400 RMax helicopters in use in Japan, which represents a 77 percent market share, according to Yamaha. The manufacturer equates the total number of people capable of operating them to about 7,500 nationwide in Japan. The difference in these types of UAS being used in Japan is the small hoppers that simply would be incapable of spraying the larger amounts of cropland present in the U.S., as it has two tanks, capable of holding only a little more than two gallons of liquid product per tank or three gallons of granular product per tank respectively. Similarly, Yamaha predicts opportunities for unmanned use in Australia and New Zealand. In separate, but related research, Denmark is working on a precision herbicide project much like that being studied by universities in the U.S.

Even though the evolvement of UAS in the United States, particularly in agriculture, has not been quite as rapid as in Japan, the integration is a fundamental tenet of the planning and implementation of the Next Generation Air Transportation System (NextGen). As such, Congress established the Joint Planning and Development Office (JPDO) under the Vision 100 – Century of Aviation Reauthorization Act in 2003. This represented a multi-agency approach and means to involve the public and private sector in the overhaul of air transportation as a whole.

In order to ensure a viable public-private partnership, the JPDO established the NextGen Institute in 2005 as a clearinghouse of sorts for researching and moderating discussion and information from experts across the industry pertaining to NextGen. In 2009 the FAA teamed with its government counterparts, NASA and the Departments of Defense and Homeland Security, to form a UAS Executive Committee (or “ExComm”) to address UAS integration issues. In addition, the FAA also enlisted the assistance of industry and academia stakeholders through the UAS Aviation Rulemaking Committee and RTCA SC-203. The latter, serving as a federal advisory committee, was formed in 2004 to develop “standards, certification criteria, and procedures for sense and avoid systems as well as protocols to be used for the certification of command, control and communication systems in the defined flight environment.” Within the FAA, the UAS Integration Office was created in January 2013 to focus integration efforts within the agency under one executive; however, integration operations have been in progress for some time prior to its formal creation.



The University of California-Davis is researching the viability of using unmanned helicopters for agricultural purposes. UC Davis is making test applications on a research vineyard in Oakville, Calif.

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According to the latest Government Accountability Office (GAO) report issued in February 2013, the FAA authorizes all UAS activity, judging each on a case-by-case review for safety. This includes “all domestic military; public (academic institutions, federal, state and local governments including law enforcement organizations); and civil (private sector entities) UAS operations.” Under the requirements of the FAA’s Modernization and Reform Act of 2012, the agency has faced difficulty in reaching many of the deadlines—with only two of the seven having been completed as of January 2013. The most recent deadline to be missed is establishing a program to integrate UAS at six test ranges; however, due primarily to privacy concerns this selection has been delayed as well. The “no later than date” of Sept. 30, 2015, for the safe integration of civil unmanned aircraft systems into NAS remains the ultimate goal, but much will need to be accomplished in terms of alleviating safety and privacy fears should this deadline remain realistic.

Safe Integration Challenges

The General Aircraft Manufacturers Association (GAMA) estimates there are approximately 223,000 general aviation aircraft in the U.S, therefore it is critical UAS do not endanger NAS users. In fact, the FAA has long stated its primary goal with the integration of UAS into the NAS is safety. In remarks at the AUVSI conference in 2012 FAA Administrator Michael

Huerta stated the FAA’s mandate is to ensure that the largest and safest aviation system in the world continues to become even safer with the introduction of UAS. However, Administrator Huerta pointed to two challenges that must be addressed to maintain this record: operational issues like pilot training and “see and avoid” technology that allows aircraft to continue operating safely even if they lose their link to their pilot. NAAA wholeheartedly agrees that resolving these two fundamental safety issues is paramount before UAS can begin to be safely integrated into the NAS.

The aforementioned GAO report highlighted several key regulatory and safety issues that require tackling before the safe integration of UAS into the national airspace. In addition to the research and development of the necessary capability to “sense and avoid” other aircraft and airborne objects, other significant concerns include improvements in “lost link” technology and a dedicated radio-frequency spectrum so that communications between UAS and operators functioning in a ground control station can rely on a dependable and dedicated spectrum without the fear of losing command and control of a UAS. Additional uncertainties include GPS jamming and spoofing as well as multiple human factor issues, similar to those encountered by pilots of traditional aircraft, but potentially magnified in an unmanned aircraft environment.

According to the FAA UAS integration office, the Agency expects to formulate a standard by 2016 that will permit UAS to inter-operate with manned aircraft using “electronic means” to see and avoid potential collisions. Jim Williams, manager of the UAS integration office, stated that the FAA is looking to amend the federal aviation regulation to allow for an electronic sensing system.

NAAA has been active in the discussion surrounding UAS, as the ability of pilots to see and avoid other aircraft and hazardous obstructions is paramount to ensuring the safety of low-level aircraft pilots. Each year pilots flying at the bottom of the NAS are exposed to a greater number of in-flight hazards, such as wires, and a multitude of towers. Next on the horizon is the imminent likelihood of UAS. As such, NAAA has met multiple times with both the FAA Obstruction Evaluation Group (OEG) as well as the UAS Integration Office. The Association has submitted correspondence to the OEG documenting low-level concerns as well as comments to the FAA regarding UAS test sites and privacy concerns. Additionally, NAAA was contacted by the NextGen Institute and participated in an interview regarding UAS and its impacts on agricultural aviation. Most recently, NAAA submitted a letter to FAA Administrator Huerta urging the implementation of low-level marking, lighting and database development solutions for locating ground affixed and UAS obstacles. In addition, NAAA requested the FAA require strobe lighting for UAS and standout painting for pilots of manned aircraft to easily see. NAAA has also been in contact with a number of congressional offices about its UAS concerns as well as the UAS trade association AUVSI. NAAA is aware of

the important functions which can be accomplished by UAS, including those to agriculture, but protecting the safety of current and future users of the NAS is mandatory and top of mind for the agricultural aviation industry.

Assessing UAS' Agricultural Capabilities & Limitations

The agricultural angle of unmanned aircraft is being liberally touted by the media, and currently at least five U.S. universities are researching the feasibility of unmanned helicopter use for agricultural purposes. The University of California-Davis's (UC Davis) research vineyard in Oakville, Calif., recently used a 200-pound RMax helicopter with a slightly more than four-gallon hopper capacity in an experimental scenario as researchers gathered data on the likelihood of potential agricultural pesticide application use. According to UC Davis Professor of Agricultural Engineering Ken Giles, the entry point for the helicopters would be to use them on hillside farms where the terrain is hazardous and time-consuming for tractors to navigate. Giles stated, "The unmanned helicopter technology allows precision positioning. In the U.S. right now there is no commercial use of this technology—it's strictly a research and development effort."

Within the aerial crop imagery industry, UAS development has begun to move at a quicker pace and in some instances is already beginning to prosper. A North Dakota-based company, Field of View, aims to bridge the gap between unmanned aircraft and precision agriculture. The company's flagship product, GeoSnap, is an add-on device for multispectral cameras mounted on aircraft (manned or unmanned) that takes the images captured and maps them with real-world coordinates—or "georeferences"

them. Field of View hopes to market such revolutionary products as a time-saving measure to farmers who already scout their fields anyway. CEO David Dvorak cautions that aerial crop imagery is not "a cure-all." He sees it as an additional tool in a farmer's toolbox to help them manage their farm. Field of View recently began selling the add-on devices at \$5,000 per unit with the cameras costing an additional \$4,000 each. To date, Field of View has sold about half a dozen, but Dvorak states, "I'm quietly confident there's this perfect storm brewing where the precision agriculture market really takes off and the civil UAS market takes off."

NAAA interviewed representatives from the two leading manufacturers of ag airplanes used in the industry today, Air Tractor and Thrush, to inquire about how current manufacturers view the potential uses of UAS in the agricultural industry. Air Tractor President Jim Hirsch responded that he has been involved in discussions of making the company's aircraft into unmanned aircraft for uses other

than the application of agricultural chemicals. Hirsch felt one of the most difficult problems to overcome is the lack of situational awareness when the pilot or UAS controller is not sitting in the cockpit. A human pilot can sense situations where his input may be needed. "Controlling an aircraft remotely is somewhat similar to viewing the surroundings looking through a soda straw," commented Hirsch. This is essentially the same as administrator Huerta's "see and avoid" operational issue.

Proponents of using UAS for spraying say the technology exists to control the aircraft's location and movement both horizontally and vertically using electronic control within a more exact tolerance than a human can control the aircraft. Only a few years ago, swath guidance was done by human flagman: then automatic flagman or no flagger; and then the miracle of GPS. As we believe no one can argue against the accuracy of GPS marking, perhaps the next sequential step is to incorporate the guidance system of the UAS into the manned



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Under current U.S. law, the only difference between a UAS and model aircraft is user intent. Per a 2007 FAA policy, aircraft without an on-board pilot intended for commercial purposes are considered unmanned aircraft and cannot be used without special authorization from the agency. UAS intended for recreational use are considered model aircraft and can be used as long as they do not compromise the safety of manned air traffic.

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—*Field of View CEO David Dvorak*

ag aircraft and use it similarly to an autopilot in a passenger aircraft. This step may improve the accuracy of the application while still being monitored and reprogrammed as necessary for existing conditions, such as people or animals moving adjacent to the target area. One hurdle to overcome will be whether the industry will be able and willing to afford what is sure to be markedly increased costs in these additional avionics.

Jody Bays, Vice President of Product Support and Development for Thrush

Aircraft, shares many of the same feelings as Hirsch at Air Tractor. He believes the technology may be available but it may take many years to work out all the problems with safety. Even if the technology is possible, it may not be economically viable. Bays feels another obstacle is being able to safely terminate the flight in the case of loss of control signal. For this reason, helicopter type equipment may be easier to certify because they can be pre-programmed to land immediately upon loss of guidance signal in the field where they are operating.

Hirsch thinks one of the more daunting tasks would be to gain certification of the UAS control system by the FAA. Currently, certification of a particular aircraft depends on demonstrating safety if there is a catastrophic failure of one or more of the aircraft’s systems. The FAA maintains that they and the public will accept only certain risks when evaluating safety. For example, for aircraft in the airline fleet, they must prove a safety rate due to a catastrophic failure at one in a billion throughout the life cycle of the aircraft model. This rate decreases with the use of the aircraft. VFR restricted category aircraft have a lesser safety requirement. Even restricted aircraft which are prohibited by FAR §91.313(e) from flying in certain areas, like over densely populated locations, are required to prove they are able to minimize the hazard to persons on the surface. The bar is likely to be

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raised even higher for an unmanned restricted category aircraft.

Amidst all the potential and unknowns alike for UAS, the U.S. House of Representatives has weighed in on the technology as well and formed an Unmanned Systems Caucus under the leadership of Co-Chairmen Buck McKeon (R-CA) and Henry Cuellar (D-TX). The Caucus aims to educate members of Congress and the general public on the value of unmanned systems, to support the development of more systems, and to engage the civilian aviation community on unmanned system use and safety. In a UAS flight demonstration in Kansas over the summer, U.S. Senator Jerry Moran (R-KS) applauded the potential for agricultural uses of unmanned systems in Kansas. He stated, “The number of ways farmers and ranchers can utilize UAS are endless—from mapping the spread of disease or insects within a field to applying fertilizer to a specific area of crops—and I look forward to continued progress in this field.”

NAAA Executive Director Andrew Moore stated there may be a place for UAS within agriculture in the future. “I foresee a big part of the technology being beneficial for checking crops and determining when and where in the field the most efficacious applications should be made. In regard to applications, however, current UAS are too small to be efficient for agriculture in the U.S. where fields are much larger than in Japan. The ability to make timely applications as well as fuel and labor costs associated with multiple reloadings will put a 20-gallon UAS at a marked disadvantage compared to today’s significantly larger manned ag aircraft.”

Among those anxious to see UAS in action for precision agriculture and beyond, there are other groups with mounting fears over privacy concerns motivating them to take unorthodox actions. Take for example the small town of Deer Trail, Colo. The town board will be voting on an ordinance that would create drone hunting licenses and offer bounties for unmanned aerial vehicles. Essentially

the ordinance would reward \$100 to any shooter who presents a valid hunting license and certain identifiable parts of an unmanned aerial vehicle. While many in Deer Trail see the idea as a novelty and a way to make money for the town, others take it very seriously. One resident stated, “This is a very symbolic ordinance. Basically, I do not believe in the idea of a surveillance society, and I believe we are heading that way.” In response to the proposed ordinance, the FAA released a statement warning that people who fire guns at UAS are endangering the public and property and could be prosecuted or fined. The administration reminded the public that it regulates the nation’s airspace—including that over cities and towns. Some states are opting for widespread privacy control, and the National Conference of State Legislatures recently reported that eight states have enacted legislation to control the use of drones, and 35 others have considered it or now are considering it.

Sky’s the Limit?

Good or bad, the possibilities appear limitless, yet the UAS technology is still proceeding cautiously as companies wait and see how the FAA regulates the unmanned aircraft industry. In the meantime, training individuals to pilot UAS is already occurring at more than 30 training schools across the country. Beyond training programs, the University of North Dakota and the University of Kansas both offer four-year degrees in UAV pilot training and Unmanned Aircraft Systems, while Embry-Riddle Aeronautical University offers a graduate degree in Unmanned Autonomous Systems Engineering. In a less traditional campus setting, the Unmanned Vehicle University in Arizona is the only school of its type to grant Doctorate and Masters degrees in Unmanned (Air, Ground, Sea)



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Approximately 50 companies, universities and government organizations are currently developing and producing more than 155 unmanned aircraft designs.

“Controlling an aircraft remotely is somewhat similar to viewing the surroundings looking through a soda straw.”

—Air Tractor President Jim Hirsch, expressing reservations about the situational awareness of UAS

Systems Engineering and a certificate in UAS Project Management as a totally online curriculum.

External to agriculture, entrepreneurs are jumping on the UAS bandwagon and visualizing the unmanned aircraft phenomena as a potential solution to global poverty problems. A Palo Alto, Calif.-based startup, Matternet, is already developing a courier network of small drones that could potentially be used to transport small, lightweight goods, like medicine or other essentials, in rural and poor areas of the world where access to traversable roads can be unpredictable. While the idea of unmanned aircraft delivery may seem *Jetsons*-like, even the Marines are already using unmanned remote-controlled helicopters as a safer means of delivering supplies to troops at Afghan outposts.

In other related unmanned aircraft developments, the venture capitalist firms of Google Ventures and Andreessen Horowitz announced in June a \$10.7 million investment in a company, Airware, creating a common platform for drones that would allow developers to create industry-specific applications. Andreessen Horowitz believes the potential of Airware is similar to that encountered in the early PC industry. It would ultimately allow for specific applications, like that of precision farming, to be created without worrying about the specific underlying hardware and instead build on Airware's platform—much like Adobe Systems Inc. built Photoshop on Windows.

Notwithstanding the positive hype and publicity surrounding UAS and its multitude of potential uses, the technology must still jump through several privacy and safety hurdles at the FAA and now possibly within Congress before full integration is possible. While the House version of the 2014 Transportation, Housing and Urban Development (THUD) Appropriations Bill recognizes the importance of the UAS innovation, it calls for progress in developing a regulatory framework and instructs the FAA to develop a “lessons learned” report as well as a plan to resolve issues arising as a result of integrating UAS into the NAS. The Senate version of the transportation appropriations legislation goes a step further and prohibits the FAA from issuing final regulations on the integration of UAS into the national airspace until collaboration with other federal agencies has occurred that evaluates the impact that broader use of UAS in the national airspace could have on individual privacy and must be completed within one year's time. Unfortunately, because the House pulled its THUD bill before the August Congressional recess, it may be some time before Senate and House conferees are able to decide the best course of action for UAS, which will likely determine just exactly how soon we can expect to see unmanned aircraft in the skies near us.

Safely incorporating unmanned aircraft systems into the national airspace is undoubtedly of utmost

importance for manned aerial applicators since we will likely be working at similar altitudes. As aforementioned, NAAA has made our concerns known to FAA Administrator Huerta and requested that to ensure safe coexistence, UAS will need to be well lit, marked and have their operational activities made known to manned pilots of low-level aircraft via a similar database system as would be ideal for obstacles 50 feet or more in height. Preferably, to avoid collision, if UAS worked at a higher level of airspace, perhaps 1,000 feet or higher, it would add an additional level of safety to our low-level aerial applicator pilots. In addition, the training and licensing of UAS operators should be equally as stringent as that for aerial application pilots both in terms of obtaining commercial pilots' licenses and commercial pesticide licenses, as well as frequent upkeep of equipment.

As an industry, agricultural aviation prides itself on its professionalism and efficacious and judicious application of crop protection products; therefore, we must ensure we play an integral role in the implementation of NextGen, specifically as it relates to the safe integration of unmanned aircraft into low-level airspace.

Aerial applicators are highly trained professionals who have made a very large investment in their business, and like all Americans, are concerned with human health, the environment, security and performing their job in a responsible and safe manner. NAAA is committed to working in tandem with the UAS industry to ensure ag aviators are able to continue performing their jobs without the additional concerns of unidentified aircraft occupying the same airspace and potentially and unnecessarily endangering the safety of low-level ag pilots. ■