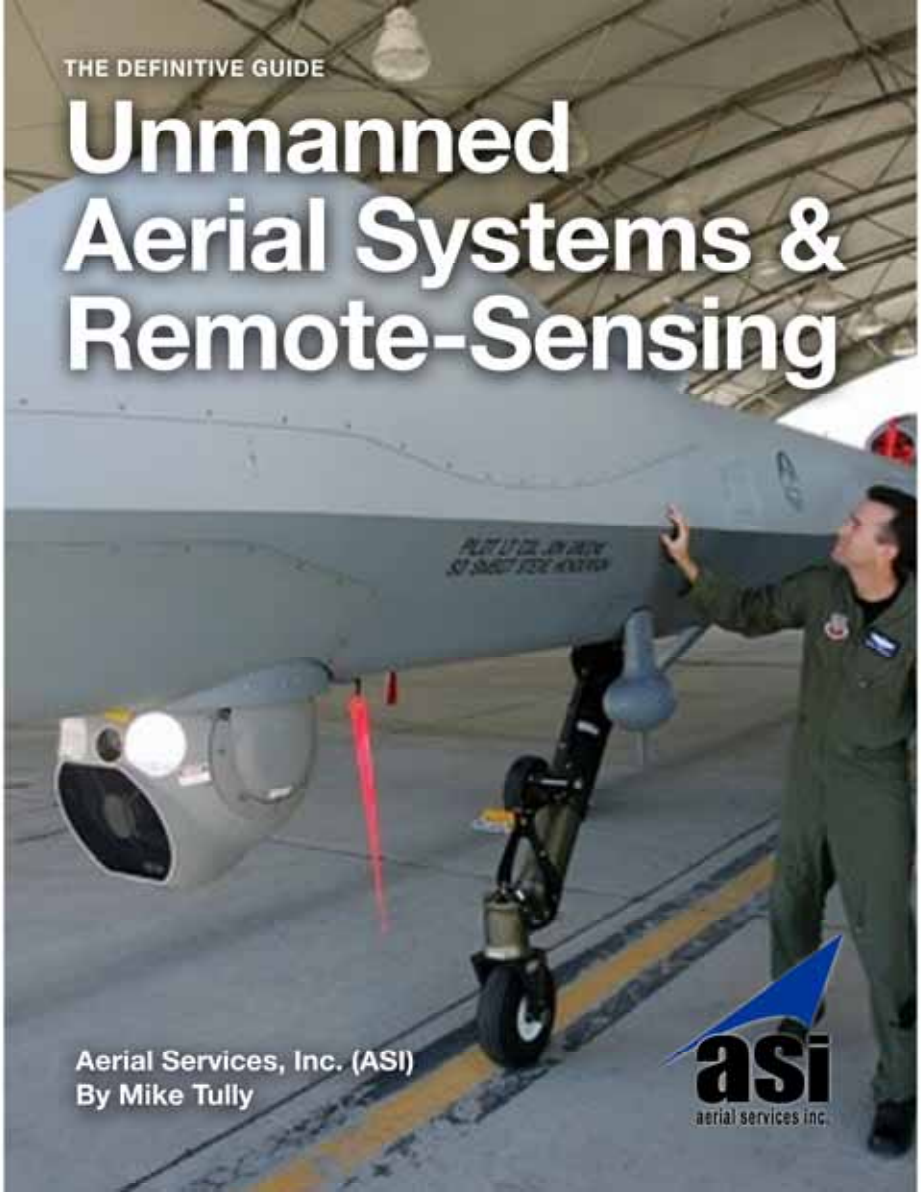
THE DEFINITIVE GUIDE

Unmanned Aerial Systems & Remote-Sensing



Aerial Services, Inc. (ASI)
By Mike Tully

asi
aerial services inc.

Chapter 1

UAS Revolution

They're coming … unusual, unmanned, flying machines. Some have already been mistaken as extraterrestrial. Some will be big and some will be the size of insects. They will be equipped with a wide variety of miniaturized remote sensing equipment. They are real today. As with any new technology, their use promises to be for extraordinary good and, like the plow, will bring some to extraordinary fear, much of it warranted.

UAS Revolution

IN THIS CHAPTER

A technological earthquake is coming. Warring robots are bringing home a new wave of high tech wizardry. Geospatial paradigms are about to change. Powerful socio-economic and political pressures are bearing down to squeeze diamonds from unmanned aerial systems (UAS). As Google Earth brought web mapping to the masses, UAS will bring mapping into every facet of our lives and work. Remote sensing has been proprietary and expensive. UAS will make it unrelenting and ubiquitous. Our lives and businesses will change. Our 21st century skies are about to become animated like the Jetsonian skies of 2062.

Here comes the UAS Revolution.

The Forthcoming Unmanned Aerial Vehicle Revolution

They're coming … unusual, unmanned, flying machines. Some have already been mistaken as extraterrestrial. Some will be big and some will be the size of insects. They will be equipped with a wide variety of miniaturized remote sensing equipment. They are real today. This is not science fiction. In October 2002, the U.S. military admitted for the first time that unmanned aerial vehicles (UAVs) were used in war. As with any new technology, their use promises to be for extraordinary good and, like the plow, will bring some to extraordinary fear, much of it warranted (especially if you are a bad guy).

Bad Reputation?

The press has reported a number of negative, sensational accounts (Cattle Rustling,Homeland Security) of UAVs being used to "spy" on Americans. One account about the EPA using drones to spy on Americans has since been proven a complete falsehood but has perhaps helped cement into many minds the "dark side" of this disruptive technology. It is unfortunate our exposure to the early use of this important technology is from an over-abundance of bad press.

"UAVs" Have Been Around A Long-Time

Aerial remote-sensing and "UAVs" have been around a long time. One of the earliest uses of unmanned aircraft taking aerial photographs was in World War II when the Germans experimented with pigeons specially trained for the aerial missions using 40-gram cameras strapped to their chest. These early UAVs share the same important attributes that will make modern aircraft indispensable in new applications in the coming years: autonomous flying, capable of long-distance travel, hazard avoidance, and reusability.

We're All Learning, More To Come

In several articles that will follow, Aerial Services will explore why UAVs have suddenly become big news in the U.S. and how they promise to become one of the most important remote sensing tools ever developed. Stay tuned!

ORIGINALLY PUBLISHED

- Aerial Services, Inc. (ASI), July 19, 2012
- Mike Tully, CEO of Aerial Services / Author

The Future with Unmanned Aerial Systems (UAS)

You order a pizza for delivery. Later your cell phone rings and the voice says “your pizza is at the door”. You reach out and remove the pizza from the unmanned aerial drone, it retrieves payment from your NFC-enabled device, gives you a receipt, and flies off.

A technological earthquake is coming. Warring robots are bringing home a new wave of high tech wizardry. Geospatial paradigms are about to change. Powerful socio-economic and political pressures are bearing down to squeeze diamonds from unmanned aerial systems (UAS). As Google Earth brought web mapping to the masses, UAS will bring mapping into every facet of our lives and work. Remote sensing has been proprietary and expensive. UAS will make it unrelenting and ubiquitous. Our lives and businesses will change. Our 21st century skies are about to become animated like the Jetsonian skies of 2062.

Both autonomously-controlled and remotely piloted UAS promise to have broad implications for our society, the economy, and for existing remote sensing businesses. Over the last several years we have seen tremendous applications of UAS around the world that promise to benefit society. They are being used responsibly in precision agriculture; search and rescue; and for surveilling wildlife; hazardous environments like forest fires, nuclear reactors, armed men. These are low hanging fruit for this technology, the tip of the iceberg of future commercial applications.

The promise of UAS is threatened by the trammels of regulation within the U.S. Federal Aviation Administration (FAA). Legislation in 2012 mandated the full integration of UAS in 2015 into the national airspace for Civil / Commercial use of UAS. Few believe the FAA will meet this deadline due to bureaucratic farcicality pivoting around privacy and fourth amendment concerns that have arisen in the last several years. Like the plow that came before it, too many people choose to envision only the threats to privacy and personal security from the improper use of these amazing technologies and neglect to envision the great good that they will enjoin.

Predictably, the stakeholders with billions of dollars of investments in drones and those eager to unleash commercial applications are deeply concerned by the delays. Years before this legitimate commercial activity can begin in the U.S., large business opportunities exist (Table 1). According to Oxera, the

geospatial industry is growing at 30% per annum globally and generated $75B in revenues in 2011, 500k high wage jobs. Geospatial services drive $1.6T in revenue and are used on a daily basis by about 5.3M workers. In foreign countries that currently allow the commercial use of UAS, remote sensing markets continue to grow.

Year	Total Direct Spending	Total Direct Employment
2015	$1,153,370,225	11,400
2016	$2,306,740,450	22,800
2017	$3,460,110,675	34,200
2018	$3,633,116,209	35,910
2019	$3,814,772,019	37,706
2020	$4,005,510,620	39,591
2021	$4,205,786,151	41,570
2022	$4,416,075,459	43,649
2023	$4,636,879,232	45,831
2024	$4,868,723,193	48,123
2025	$5,112,159,353	50,529

Table 1. Direct Spending and Employment in The U.S. from 2015-2025. (The Economic Impact of Unmanned Aircraft Systems Integration in the United States. AUVSI, 2013

The combination of four key technologies: miniaturization, communications, positioning and orientation systems, and remote sensing (EO and Lidar) technologies, promise to be a disruptive shock to the geospatial and remote sensing markets in the U.S. What threats could these robots have on the remote sensing and geospatial professions? What amazing and lucrative opportunities might arise for those innovative entrepreneurs and geospatial practitioners that successfully envision new business models and exploit revolutionary technology? This three-part article will explore what these new, disruptive technologies may look like ten years out and what impacts they could have on existing business models especially in the geospatial profession.

This vision of the future is, of course, limited and depicts only one of many possible futures. These musings of a practitioner are more about beginning a serious discussion than about predicting future. It is becoming increasingly clear that UAS technology will alter the business or social landscape not only in the geospatial realm but also in many others. This revolution will disrupt the status quo, alter the way people live and work, and shift pools of business value. It is therefore critical that business and policy leaders understand why these technologies will impact them and prepare accordingly.

UAS Waves of Adoption

The UAS disruption to geospatial and remote sensing is likely to proceed in waves over the next 10 years. The initial wave will be the erosion of current markets and the growth of many new markets by persistent, high resolution (12" or better GSD) microsatellites that promise "currency" of imagery and far more flexible than current satellites. Microsatellites are not typically considered UAS, but are included in this discussion because of their potential and significant near-term impact on geospatial and remote sensing.

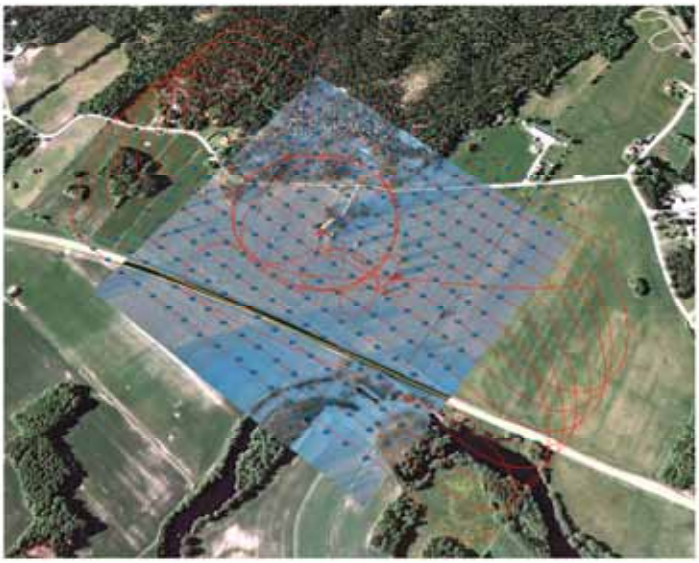
Then over the next five years the application of small UAS (sUAS) will further disrupt geospatial markets. Today, our commercial application of UAVs is extremely limited: small vehicles (<25 lbs),

limited duration (15-60 min), and line-of-sight operation limited to non-populated areas only. The FAA may not require sUAS to integrate the sense and avoid technology that will be critically important for the safe integration of large UAS into the national airspace. Therefore, the growth of sUAS will not be significantly thwarted by the slow adoption of this technology. However, it will, certainly be perturbed by overly restrictive legal and regulatory environments. But within this period non-geospatial professionals in a variety of new markets will be enabled to affordably create basemap products (orthophotography and digital elevation models) of small areas (less than 500 square miles) in a highly automated fashion.

The final wave, 5-10 years out, will be the adoption of large UAS that will enable large-area, persistent and highly automated unmanned mapping. This will be highly dependent upon the adoption of sense and avoid technology, sensible regulation, and a favorable legal environment.

Amara's Law

Amara's law says "we overestimate the impact of technology in the short-term and under-estimate it in the long-term." It is unlikely UAS will replace current remote sensing technologies. Much like TV was touted to kill radio, then internet was to kill newspapers (although we may be witnessing this finally), and Amazon.com was to destroy brick and mortar stores, the reality generally turns out different. A new technology can be



"Tingstorp UAV map" by Jeff Warren, Attribution-ShareAlike License http://bit.ly/1m6zn9q

"disruptive" and still allow older technologies and business models a relevant place in society within what evolves to be more complex markets… at least for a while. Assuming we achieve the full integration of UAS into the national airspace (NAS), there may be a need for traditional remote sensing companies (manned flight with large, metric sensors) in the future. They are likely, however, to occupy a fraction of the market they do today.

The flip side of Amara's Law also speaks to the coming future shock: "we often under-estimate the impact of technology in the long-term". Paradigm shifts are often more catastrophic to

existing businesses stuck in the "old" paradigm than companies that are born after the disruption. Kodak actually invented in 1975 their industry's disruptive technology – the digital sensor. However, they made +60% margins on film and chemicals and anticipated only 15% margins on digital cameras (see this Forbes case study). They couldn't "see" through the "silver curtain" to a world of digital sensors. They failed to emphasize digital photography for decades … until it was too late. Today, the company, synonymous with modern photography, is gone! Similar disruptions caused by Thomas Edison's invention of the first commercially practical incandescent light bulb and the first scalable distribution of electricity spelled similar doom to many businesses in the late 19th and early 20th century.

Today's geospatial and remote sensing companies will suffer a similar fate if they cannot pull the "curtain" off their eyes and find the "silver" in the coming rise of flying sensing robots. Clay Christensen speaks of the innovator's dilemma in that it's very difficult for large, established companies to keep innovating. They often can't see "beyond the curtain" or muster the courage to disrupt their existing revenue streams. Kodak, newspapers, cable TV, and brick and mortar stores all exemplify this dilemma. Unless and until traditional remote sensing companies and many disciplines within the geospatial services profession consider UAS as fundamentally transformative, they will be condemned to a strategically flawed path. Likewise, as new rapacious innovators unhindered by today's remote sensing paradigms seize upon UAS technologies, a plethora of new opportunities will be discovered.

Flying Sensing Robots

To catch a glimpse of what may be approaching with unmanned flying systems, consider the driverless car. In 2008 a state-of-the-art driverless car could go two blocks on its own on a closed course at 25 mph. But by 2012, the driverless car could operate in real-world conditions at 75 mph and autonomously navigate notoriously stressful urban interchanges. Once the commercial UAS market opens up, we will see a rapid convergence of the four key technologies (flight, remote sensing, communication, position, and computing) that will seem "magical" from our vantage point today.

A few years ago remote sensing firms could market "position and orientation" with each aerial frame using GPS and inertial measurement units. Today, this is no longer a competitive advantage but an industry expectation. Today, we market our amazing 3D constructs of reality from remotely sensed data. Tomorrow, the expectation of realistic 3D all the time from our flying platforms will be the norm. We are approaching an age that I refer to as "Ubiquitous Remote Sensing (URS)". Three-dimensional mapping will be conducted continuously almost everywhere at engineering scales. Miniaturization will make this possible and remote sensing gear will be put into everything. Our cars will map the roads as we drive (if we are driving the car!),

farmers will map their crops anytime more easily than they now plow. Cities and counties will update their 3D maps as changes occur using inexpensive UAS technologies that they own and operate (or perhaps procure as a service).

Today, it is inconceivably expensive to ponder continuously updated imagery and 3D maps across vast areas like the continental U.S. But when vast networks of inexpensive and adaptive flying cameras (remote sensing platforms) are always operating and networked with each other and with the processing center, this scenario seems much more plausible. Or consider unmanned platforms operating at 60,000' (or even microsatellites in low earth orbit) above all commercial passenger traffic. They will remain aloft for days or weeks and continuously capture high resolution photography across vast areas of cloudless geography. Rich information will be beamed down in real time to Google, Microsoft, and Apple geographers for publication to their solutions.

What do traditional aerial photography and remote sensing firms do when one company's fleet (or more aptly "network") of unmanned sensing platforms perform all their current operations at less than half the cost, at higher resolution, and in less time? As more capable UAS are deployed in different markets, the rapid basemap production and the ability to provide streaming maps in real-time, will provide superior temporal accuracy data and better decision-making by GIS analysts and management.

The robots will learn from each other about current conditions and self-organize to exploit the best weather in the highest priority geographies. Users that now consider annual updates of their local world sufficient will realize basemap updates of their pipeline or new subdivision whenever they are needed via a simple, inexpensive purchase and "immediate" (hours or days not weeks) delivery to their geographic information system (GIS). This will mark an important shift from aerial imagery used only as a traditional GIS basemap to that of an "operational" layer. This in turn will spawn a number of new opportunities from data acquisition and processing to analysis and application. How will access to this spatial and temporal high resolution information revolutionize geospatial services? What plethora of new products and services will be invented to leverage this treasured information? New opportunity is ripe. Threats to current business models are hard, cutting, and cold.

REFERENCES

- FAA Modernization and Reform Act of 2012, H.R. 658
- What is the economic impact of Geo services?, Oxera, January 2013 (Prepared for Google)
- The Economic Impact of Unmanned Aircraft Systems Integration in the United States, Association for Umanned Vehicle Systems International (AUVSI), 2013 report
- How Kodak Failed, by Chunka Mui, Forbes, Jan. 13, 2012

Chapter 2

Business & Privacy Issues

New technology often renders things previously thought impossible possible. Novel applications of technology often intersect with culture and tug at constitutional protections. UAS are no exception.

Chapter 2 · Section 1

Business & Privacy Issues

IN THIS CHAPTER

As unmanned aerial systems (UAS) become more prevalent in the skies, the United States is engaged in spirited conversation about their impact on the constitutional guarantees of privacy and free speech. Over the next 10 years, tens of thousands of these vehicles could be safely darting in our national airspace, providing a wealth of valuable services to homeowners, ranchers, farmers, journalists and businesses. Many of these vehicles will be equipped with remote sensing technology enabling the identification of individuals. This technological leap forward brings with it challenges to our concept of "privacy" and "free speech" our society has not yet faced.

UAS, business, and privacy issues are interlocked.

Business & Privacy

It is easy to imagine a future scenario of pizza deliveries made using unmanned aerial systems (UAS). This is hardly a stretch given Americans' history of extraordinary innovation. The level of innovation with UAS technology promises to be breathtaking. Since Part 1 was published, I have found real life examples of similar UAS entrepreneurship. Beer was parachuted from UAVs to eager fans at a music festival in South Africa. The flying "hops helis" were dispatched to their locations via smartphone orders. Welcome to the revolution!

Any way you shake it, unmanned aircraft will define the future of aviation just as manned aircraft have in the past. The Association for Unmanned Vehicle Systems International (AUVSI) released an economic study that predicts 30,000 UAS may be sold for agriculture purposes alone in 2015. Many more will be working overhead for other beneficial purposes, most of which have yet to be conceived. The successful manufacturers, services, and business models remain undefinable. But certainly, the U.S. and global economies will reap billions from the application of this stimulating new technology. Alas, the future is not yet written and there are significant threats to this burgeoning technology. In this article we will explore the tension between UAS and our constitutional protections of privacy and freedom of the press.

"Mosquito Drones - The Future Of Surveillance!" by ALT Headlines, Attribution-NoDerivs License http://bit.ly/RnJev7

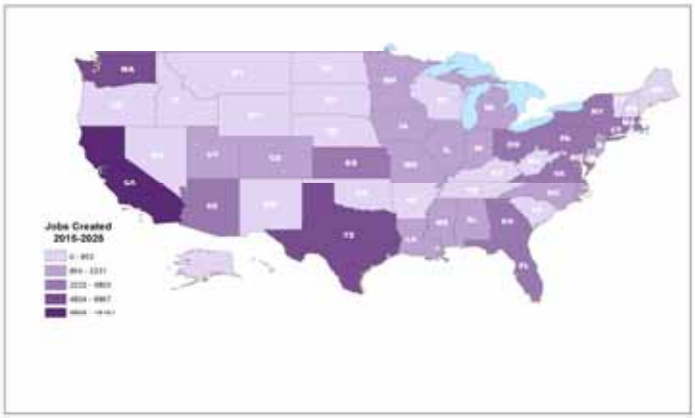
Not until 1989 was the commercial use of the internet was allowed. Few people, if any, in 1989 could have predicted the internet's effect on the world economy and global societies. It was impossible to foresee the mind-boggling applications (both good and bad) of this technology. Facebook, Google, billions of webpages, RSS, Big Data, the Cloud, and the Apple App Store all arose because innovators could freely innovate and sell stuff using this new technology unhindered by the trammels of regulation. Countless inefficiencies in business and communication were eliminated by sending packets of

information dancing across the global net. Today there are nearly 1.2 billion Internet-enabled devices used by 2.5 billion people across the planet. This foundational technology created a rolling boil of commercial and technological opportunities over the last

The Association for Unmanned Vehicle Systems International (AUVSI) economic study predicts the economic impacts in each state in the United States.

three decades forever altering society and commerce. It is truly humbling!

UAS are similar. They are foundational in a sense because they will transform our national airspace into a platform for a wide berth of beneficial applications. As with the internet, it's not possible to currently predict how UAS will be used over the next several decades. Innovators are tireless. Unforeseen applications



The Association for Unmanned Vehicle Systems International (AUVSI) economic study predicts both the number of jobs to be created in the United States as well as their geography.

will be discovered. The positive economic effects in dollars and jobs are more apparent each week…and ironically, more threatened. Of particular concern today is the potential erosion of our constitutional protections related to the right of privacy, protection from unwarranted search and seizure, and the freedom of the press. Excess fear and panic related to the rise of UAS threaten to hamper their adoption if ballarag regulations ensue.

Right to Privacy

In the United States, the Fourth Amendment to the U.S. Constitution states, "The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated." This concept of

protection of an individual's right to privacy is not outdated or obsolete by any means. The Fourth Amendment is as essential and valid today as the day it was included in the Bill of Rights over 220 years ago. The problem is the Fourth Amendment was designed and worded within the context of technology and capabilities in existence in 1776, not 2013. The framers of the Bill of Rights never envisioned UAS technology nor how its application could be used against individual citizens.

Historically, the greatest protections of privacy have always stemmed from the practical limitations of technology—that is, to spy on someone you had to follow them around. This was labor-intensive, expensive and time consuming. But small drones using inexpensive gyroscopes, accelerometers, GPS, and cameras have forever changed this equation. As practical barriers related to "remote sensing" fall away, the resulting privacy issues will assume heightened significance. Recent revelations about the NSA reaping and reading our nation's electronic communications certainly does not help lessen the added fear of yet another "prying eye in the sky". These are legitimate concerns, as is the threat that nefarious (and just plain stupid) individuals and entities will abuse or misuse UAS or any technology.

New technology often renders things previously thought impossible possible. Novel applications of technology often intersect with culture and tug at constitutional protections. UAS are no exception. It is true that our journeys across many cities are photographed continuously by cameras mounted on store fronts and poles. Many of us have received traffic citations from the robotic sensors used to record our driving infractions. Department stores are beginning to track our location within their aisles. "Black boxes" record our travels in our own cars using GPS.

My trek across a city is recorded. But my steps can be traced by others only after dozens of separate images scattered across a

The 'HoverMast' developed by the Israeli start-up company Sky Sapience is an example of hovering camera technologies that are being developed.

large number of private and public sensors are consolidated. Warrants are required to obtain many of those images. Additionally, I am aware of sensors along that path and I have no reasonable expectation of privacy in these public spaces. Our society has wrestled with much of this and, in some sense, has come to terms with this level of surveillance, i.e., in public or commercial spaces. Most Americans can live with this.

Justification for Concern

The "resolution", "stealth", and "persistence" of UAS constitute brand new threats to Americans' privacy. UAS will provide the ability for private citizens and the government to put a single camera in the air over my head. I will not know it's there. It cannot be observed. Manned aircraft are generally not flown below 1000' above ground level.

When flying at high altitudes, powerful (and expensive) sensors are needed to produce high resolution imagery capable of revealing sensitive details like the identity of a human face. But UAS can be flown at any altitude, even just a few inches off the ground. Today, UAS equipped with commonly available sensors and flying at much lower altitudes can easily identify human faces and other crucial details that could potentially compromise our privacy.

Furthermore, consider the "stealth" nature of UAS. Traditional methods of aerial surveillance involve considerable "noise". It's not possible to position an aircraft near a home and not be heard. Small, electric-powered UAS, on the other hand, make virtually no sound and can hover unnoticed over your home for extended periods with no pilots to fatigue.

UAS "persistence" while surveilling is also a significant new concern. A single UAS equipped with sensors can record my

"Quadrocopter" by Simon Jardine, Attribution License http://bit.ly/1kw3c0Y

movement throughout a city continuously. It can record and identify everyone I stop to talk with. Indeed, it can continuously record everyone's activity in the city. Because all this data is on a single device one individual can reconstruct my entire trek from this one recording.

Questioning these as new threats to privacy is not unimportant. These UAS applications need to bask in the sunlight of public discourse well before our law enforcement institutions are allowed to use UAS for these purposes. Indeed, in the U.S. v. Jones in 2012, although the court ruled the authorities "trespassed" a man's property by installing the GPS device in his vehicle without a warrant, the court left unanswered the constitutional question of whether the authorities violated the individual's right of privacy by tracking his movements using GPS. The types of constitutional questions considered in this case, and not resolved, may have important implications for UAS used in our airspace. Bringing our country closer to one in which every move is recorded and scrutinized by the authorities is a Silurian idea that history has repeatedly demonstrated ends in statist control and the death of freedom.

Stop Peeping not UAS

If the privacy of citizens is eroded by UAS or any technology, a system of rules is needed to ensure Americans' freedoms are protected so they can enjoy the promise of the technology. The best laws protecting privacy are technologically neutral. To the extent regulations are adopted that unnecessarily target a specific technology, the regulatory burden will become oppressive, confusing, and nescient.

For example, "Peeping Tom" laws prohibit people from looking into your bedroom window. Whether peeping is done by climbing a ladder, using a USB camera on the end of a broom handle, using a high resolution satellite sensor to peer inside, using a UAS hovering in my yard outside your window, or in the not-to-distant future, using "insect-sized flying sensors" from Walmart to fly unseen inside your home and record your activities, "peeping" (without a warrant) into your private space should be a crime. The best legislation would criminalize the act of peeping while remaining indifferent to the technology used to peep.

Today there are more than 40 states considering laws to limit UAS. Much of this activity is centered on concerns related to the protection of privacy. Certainly, it's not too early to define the limits of law enforcement (without a warrant) to use UAS to surveil what has been considered the private activities of persons. But thoughtless bans on all uses of UAS by law enforcement would be unreasonable. For example, Olaeris is marketing a small "flying disc" equipped with speakers and sensors designed to be dispatched by 911 operators to a crime scene prior to law enforcement personnel to begin recording events, and even identify and dissuade criminals in the midst of their nefarious act. Some of the laws being considered may prohibit this life saving application of UAS technology.

"Existing laws and jurisprudence in America provide an important foundation upon which our society may accommodate this "unanticipated" technological development — much like has occurred with the Internet and mobile phones." However, Kevin

Pomfret from the Centre for Spatial Law and Policy suggests that, "the entire geospatial community needs to become more actively engaged in the ongoing discussions of what is a reasonable expectation of privacy from a geolocation standpoint given recent technological developments, otherwise laws, policies and regulations are likely to develop that will make it much more difficult and expensive for businesses and government agencies to do business." Prior Supreme Court decisions and precedence are often poor predictors about how a particular decision will be made.

The warrantless observation of marijuana plants by authorities in a fenced backyard from 1000' AGL was considered constitutional because anyone could fly over in an aircraft and observe the illegal activity, including the police (California v. Ciraolo, 1986 and Florida v Riley, 1989). The government was allowed to take aerial photographs of an industrial plant from navigable airspace using traditional remote sensing equipment without violating the Fourth Amendment on basically the same reasoning (Dow Chemical v U.S, 1986). Peering "inside" a home to detect an illegal marijuana-growing operation was ruled unconstitutional on the grounds that "advanced technology" not commonly available to the public was used to "search" inside a private space without a warrant (Kyllo v U.S., 2001). In other cases, observations at 200' above ground level, well below navigational altitudes, did constitute illegal search (Colorado v Pollock).

UAS Industry and Law Enforcement Blaze a Trail

This established case law provides a good foundation as we approach the age of Ubiquitous Remote Sensing, but clearly legislation and privacy rights will need measured definition in light of UAS advancements until our society is comfortable with this technology. Law enforcement and industry have already begun to adopt standards to guide the responsible use of UAS. The nation's police chiefs have adopted a code of conduct for the use of drones and the disposition of information collected using them. This attempt at "self-regulation" does acknowledge the legitimate

The nation's police chiefs have adopted a code of conduct for the use of drones and the disposition of information collected using them.

privacy concerns of the public and the need for a warrant prior to conducting flights that may intrude upon reasonable expectations of privacy. Earlier this year, the AUVSI released a similar "Code of Conduct" for the safe and responsible operation of UAS. These actions by trade and law enforcement groups are constructive and may provide the needed framework to usher in the safe, responsible use of UAS.

There will always be those who work outside of the law. The bulk of future offenders can be marginalized by existing laws and sensible regulation, but also by insurance (after the UAS insurance risk assessment and products mature). Insurance can be used effectively to marginalize those who will use UAS to violate others constitutional rights (The Path to UAS Commercialization, Darryl Jenkins, August 2013, AUVSI 2013 Conference Proceedings [Subscription]). The UAS operator responsible for recently crashing a small aircraft into a crowd of spectators at a Bull Run festival in Virginia may endure such "marginalization" because of liability exposure.

Certainly, social norms will evolve and adapt to an airspace replete with flying robots. Overreaction to "potential" violations of privacy with rampallian regulations will enervate and stupefy the future potential of UAS. We should not preclude UAS innovation today with overly prescriptive privacy regulations, but instead, encourage innovation and address tangible harms as they develop. Withholding regulation until after our nation has real experience using UAS will ensure a fertile ground in which innovation can flourish as it did with the Internet and mobile phones industries since the 1990's.

Privacy versus Free Press

Of course, on the flip side of "privacy" are our constitutional protections of free speech and a free press. Private entities are not bound by the Fourth Amendment restrictions that apply to the government. The key constitutional question is the extent of a citizen's First Amendment (freedom of speech and of the press) privilege to gather information.

How long will it be before a journalist, paparazzo or stalker flies a UAS into the "private spaces" (whatever that might be) of another person? Does a journalist have the "right" to "hover over" those injured at the scene of a traffic accident and take high resolution images of the victims without their consent? Do paparazzi have the right to use UAS and "lock onto" a movie star in order to persistently and silently follow and photograph them? Do journalists have the first amendment right to gather news by using UAS to monitor wireless signals of individuals or organizations? If I fly my personal UAS near your property at treetop heights do I have the right to post on Facebook a picture of a document photographed on your patio?

In the end UAS are nothing more than machines or tools that can be used for a variety of purposes and in a variety of ways. The technology is generally not the threat to our constitutional liberties. The operation and use of that technology, and the information it captures, is the actual threat. This intersection of my right to privacy and your right to take pictures (or record sound) will most assuredly be fleshed out in the coming years.

The FAA and Privacy

This discussion of privacy and UAS intersects the FAA Modernization and Reform Act (FMRA) of 2012. This legislation instructed the FAA to "provide for the safe integration of civil unmanned aircraft systems into the national airspace system as soon as practicable, but not later than September 30, 2015." The FAA is responsible to ensure all private and commercial airline passengers continue to fly safely in the skies over our nation alongside unmanned vehicles. The FAA's commitment to get right the integration of UAS into national airspace is laudable. The FAA is the best group to insure safe travel in our airspace.

Our national airspace is arguably the safest in the world due in large part to the FAA's oversight. They could be, however, the worst group to handle the extremely complicated and legal aspects of privacy. How and why they have staked out a position to ensure UAS are used in ways that do not compromise constitutional protections of privacy is still unclear.

Congress's charge to the FAA was simply to ensure the safe integration of UAS into the national airspace. There are no references to "privacy" in the FMRA. As previously discussed, there already exist federal, state, and other laws that protect an individual's right to privacy. The FAA should leave questions of UAS privacy to other institutions and focus on what they do best … "provide the safest, most efficient aerospace system in the world".

Our rights to free expression and privacy are not absolute. As citizens of the United States we have an obligation to be constantly vigilant and informed so that we remain protected against official depredations. Equally important is striking a balance with protections of our constitutional rights and not hindering the innovation and application of a new technology by over-regulating UAS out of fear or misinformation. At risk are the enormous societal and economic opportunities inherent with this exciting new technology.

ORIGINALLY PUBLISHED

- Sensors & Systems / September 24, 2013
- Mike Tully, CEO of Aerial Services / Author

Privacy Issues Raise Concerns for Remote Sensing

As unmanned aerial systems (UAS) become more prevalent in the skies, the United States is engaged in spirited conversation about their impact on the constitutional guarantees of privacy and free speech. Over the next 10 years, tens of thousands of these vehicles could be safely darting in our national airspace, providing a wealth of valuable services to homeowners, ranchers, farmers, journalists and businesses. Many of these vehicles will be equipped with remote sensing technology enabling the identification of individuals. This technological leap forward brings with it challenges to our concept of "privacy" and "free speech" our society has not yet faced.

For example, if you do not "own" the air above your property, can individuals, businesses or government officials fly their camera over it and record high resolution video of your barbecue and identify everyone gathered there? Can a media organization or law enforcement agency "virtually" follow you everywhere you go silently recording your journey from 200 feet overhead? What expectations of privacy do we have from high-resolution flying camera in the national airspace? How does this new high-resolution geospatial and personal data impact privacy, free speech and the geospatial professional?

Two Communities, Two Perspectives

There are two distinct conversations currently taking place with regard to UAS and privacy. One discussion is taking place within the very active privacy community. This discussion consists chiefly of privacy advocates, lawyers and policymakers. Some of these have an engineering and technical background, but very few of them have a deep understanding of geospatial technology. Fewer still understand remote sensing.

There is a second discussion taking place within a narrow segment of the geospatial community. Many of those taking part in this discussion have a deep understanding of geospatial technology in general and remote sensing in particular. Some are familiar with the few Supreme Court decisions addressing remote sensing and privacy. However, there are less who appreciate the changing perception of privacy in a public space or recent trends in privacy laws.

Unfortunately, in many instances the two groups are not speaking the same language. While privacy professionals may be familiar with a few of the more well-publicized benefits of UAS, they do not know the difference between electo-optical imagery and LiDAR, how data is captured and processed. Nor do they understand fundamental aspects of geospatial data sets. They also do not appreciate how geospatial information is integrated into a number of governmental and societal applications they take for granted every day. For example, they may not appreciate high resolution orthorectified imagery's use in forecasting flood damage, transportation planning and monitoring for crops, forests and federal lands.

Privacy, Sean MacEntee Attribution License http://bit.ly/1I5NN5S

Similarly, geospatial professionals have an understanding of their own sense of privacy. However, they often don't appreciate location privacy is much more subjective than other types of information, such as medical or financial records. It can be influenced by age, gender, religion and whether you are living in an urban or rural environment. In addition, they often fail to appreciate the evolution of the term "personally identifiable information" or the elements of popular privacy concepts such as the Fair Information Practice Principles or Privacy By Design. For example, many geospatial professionals are not aware that geolocation information sufficient to identify street name and city is protected under the Children's Online Privacy Protection Act (COPPA).

As a result, these two groups are talking past each other, not to each other. Since privacy has become an issue favored by both conservatives and liberals, it often appears as the geospatial community is on the outside looking in at important discussion.

Communicating "Geospatial"

Given the complexity of geospatial technology, it is unlikely that many privacy professionals take the time to learn geospatial technology or the many critical uses of geoinformation. As a result, if the geospatial community wishes to make sure its voice is heard so future laws, regulations and policies are rational, consistent and transparent, it is imperative they better understand the legal and policy constructs developed around privacy and data protection.

First, consider there is no single authority responsible for privacy law in the United States. Many other countries have a single authority with this mandate. At the federal level Congress, the Federal Trade Commission (FTC), Department of Commerce and

federal courts all have some say in privacy. In addition, the legislatures and court systems of each state also have jurisdiction over certain aspects of privacy. In fact, a decision by a court in the state of California about a zip code being "personally identifiable information" under California state law may have the most far reaching impact on the geospatial community. The California court's analysis already has been applied in other states, including Massachusetts and New Jersey. In addition, one can expect smart (and aggressive) plaintiffs will try to use this case as precedent in other matters that involve location privacy.

Second, legislation was introduced in more than 40 states to address concerns associated with UAS. While not all of these bills have become law, at least eight states have passed legislation regulating UAS with regards to privacy. Many of these concern the use of UAS by law enforcement, probably because law enforcement and EMS are the primary users of the technology at this time. However, other legislation, such as in Texas, would restrict the use of UAS by private citizens.

The geospatial community also needs to recognize concepts of privacy are changing, particularly with regard to location. For example, members of the geospatial community are often heard expressing the view that information collected on an individual in public places does not infringe upon that individual's privacy. The Supreme Court decided not to directly address this issue in the case of U.S. v Jones, regarding the use of GPS tracking devices

Unmanned aerial vehicles will be used to inspect critical infrastructure less expensively than possible today and without putting people's lives at risk.

"P1040235" by Simon Jardine, Attribution License http://bit.ly/1h1VQNb

to follow a suspect in public spaces without a warrant. However, it is clear from the decision a growing number of justices have the viewpoint that monitoring of an individual's activities for long period of times in public places may violate the Fourth Amendment. Similarly, the outcry over the map created by a New York newspaper of registered gun owners highlights even public data can result in privacy concerns.

Understanding the Law and Perceptions

It is also important for the geospatial community to recognize privacy protection in the U.S. is heavily influenced by two important concepts. The Fair Information Practice Principles (FIPP) is a widely accepted framework that is at the core of the

Privacy Act of 1974 and has been adopted by many U.S. states and many foreign nations. The core elements of FIPP include (i) notice, (ii) choice/consent, (iii) access, (iv) integrity/security, and (v) enforcement. More recently the concept of Privacy by Design has become popular in the privacy community. The concept of Privacy by Design has been supported by the Federal Trade Commission and emphasizes systematic and verifiable methods of risk management, preventing breaches of data protection, and achieving privacy protection goals "through innovative optimal techniques."

In the Big Data era, it is not enough to simply state a particular type of geoinformation should not be subject to privacy concerns.

Surveillance, Jonathan McIntosh, Attribution License http://bit.ly/1qGYq2t

It is too easy to combine disparate and seemingly innocuous data sets in ways that could identify an individual. For example, in the New York example described above, gun owners and privacy proponents only became alarmed when a publicly available list of registered gun owners was aggregated with the geospatial information contained in a map. As a result, a working knowledge of these important concepts is necessary to engage the privacy community in any discussion as to why certain types of geospatial information should or should not be regulated.

Geospatial organizations can stay informed on developments through organizations such as the Centre for Spatial Law and Policy. They can then use this information to engage with the Federal Trade Commission in their periodic meetings with the public on important privacy topics. They can also actively engage their Congressional delegation when important legislation is being considered. Moreover, there are some steps companies who collect or use large amounts of geospatial information should begin implementing internally to demonstrate they understand risks to privacy. For example, companies can train employees on the potential sensitivities associated with geospatial information and implementing proper information security.

UAS is Just the Beginning

The debate over UAS is part of a larger debate regarding privacy. The geospatial community is caught in the crosshairs. Even if one can collect UAS imagery, other information may or may not be

collected which has value and could violate privacy concerns. Without an understanding of privacy, the voice of the geospatial community is likely to be overlooked or dismissed. Without an input into such an important debate, there is a substantial risk the geospatial community will wake up one day and find that they can't do the things they want to do. Worse yet, it may find that it is no longer able to do what they currently can do with manned aircraft.

ORIGINALLY PUBLISHED

- Point of Beginning (POB), January 22, 2014

- Mike Tully, CEO of Aerial Services & Kevin Pomfret, Founder-Executive Director of the Centre for Spatial Law and Policy & President of GeoLaw, P.C. / Co-Authors

Chapter 3

Remote Sensing Expansion & Personal Geospatial

Today our national airspace (NAS) is accessible to only manned aircraft and a little over 600,000 active pilots. That's less than 0.1% of the population. UAS and its enabling technologies (miniaturization, wireless communications, and location) will help eliminate the barriers to entry of the NAS.

Remote Sensing Expansion & Personal Geospatial

IN THIS CHAPTER

For the geospatial and remote sensing professions, unmanned aircraft systems (UASs) represent the most significant onslaught of enabling technology since the first camera took flight 150 years ago. When UAS technology is combined with virtual unrestricted access to the U.S. national airspace system (NAS) for anyone and any business—think "personal remote sensing"—the repercussions for our culture and economy will grow by orders of magnitude. The influence of UAS technology will be felt in nearly every major area of commerce.

Personalized Remote Sensing options are coming.

New Opportunities in the Coming UAS Age

"Drone First Test Flight" by [illegible], some Rights Reserved http://bit.ly/1kZNvle

Unmanned Aircraft Systems (UAS) are advanced robots that will empower many citizens and professionals. In a report published by the McKinsey Global Institute, it is estimated that a potential economic impact of $14 - $33 trillion a year by 2025 from the 12 technologies discussed. One of those technologies is advanced robotics: robots with enhanced "senses" and intelligence increasingly capable to perform tasks once too dangerous or uneconomical to automate. UAS and microsatellites are a prime example of "advanced robots" that will empower citizens and professionals and give them unprecedented access to the national airspace to surveil, remote sense, and map the entire globe.

Today our national airspace (NAS) is accessible to only manned aircraft and a little over 600,000 active pilots. That's less than 0.1% of the population. UAS and its enabling technologies (miniaturization, wireless communications, and location) will help eliminate the barriers to entry of the NAS. Many very capable robots will cost as little as $300. Pilot certifications for flying UAS may not be required or will become much easier to obtain. As more people and businesses have easier access to the NAS, it will, for the first time, become a "platform" from which will spring a profusion of activities and professional services that have not been possible to date.

Innovation and UAS

Regulatory delays remain a significant barrier to the rich, rapid innovation promised by UAS. The FAA released its annual UAS roadmap for 2013 in November. It does not anticipate full sUAS integration into NAS until 2020. It remains unclear when larger UAS will achieve full integration despite the law's mandate of 2015. Additionally, privacy concerns have burdened an agency historically focused on "safety" with extraordinary legal and cultural issues that the agency has no legislative mandate to address. The longer robust civil use of UAS is delayed the more chimerical the predictions of economic activity become.

Despite regulatory uncertainty, the incredible innovative energy of UAS manufacturers and users is clearly making tracks. Ground-based autonomous data machines have been developed that are much smaller than a man and are equipped with GPS, 3d LiDAR mapping, 360 HD video, thermal imaging, night vision, OCR,

audio recording, and biological-chemical-radiation detection. This sensor, or one similar, will eventually fly.

The AEVA from Olaeris is a first response UAS designed for emergency responders to save lives, protect property, and serve the public without encroaching on constitutional rights or civil liberties.

Aerial robotic technologies are flourishing. It was only a matter of time, but UAS are advancing rapidly to the point where military experts are contemplating aerial dogfights between unmanned systems within 15 years. This may render manned aerial combat obsolete.

The good news for the geospatial profession and the UAS industry is that this same warring technology using robust sense and avoid systems will be exploited in the civil space for peaceful applications. Sense and avoid technology is an array of sensors, communication tech, and procedures that will be integrated into most UAS before full NAS integration can be achieved. Right now it is recognized that we need a man in the loop when flying unmanned systems. But the question facing the FAA and UAS industry before full integration of UAS can occur is what kind of redundancy and fail-safe tech and procedures are required for unmanned systems to fly with commercial air traffic especially, and how problems with the operation of the aircraft will be mitigated when they occur.

Activity Despite Uncertainties

The first big civil uses of UAS will be with small UAS (<55 lbs). sUAS are flourishing today for research and for emergency management purposes around the country by public entities. We may see in 2014 the first "exemptions" granted by the FAA for the commercial use of these robots over non-populated areas under line-of-sight rules outside of the special Arctic Zone. The most important initial applications of sUAS will undoubtedly include agriculture, mining, construction and infrastructure inspection, storm tracking & environmental monitoring, firefighting, and wildlife monitoring. Other early uses will include hazmat detection, real estate photography, amateur photography, and surveying and mapping.

The Skbox Skysat-1 satellite (left) achieved orbit in November 2013, and a flock of microsatellites called "Doves" from Planet Labs are expected in orbit in December 2013.

sUAS activities that have recently occurred or are occurring are indicative of a growing interest in an important technology. Commercial and research flights of sUAS have begun in the new Arctic zone off the coast of Alaska. UAS are being used here so NAS stakeholders can learn how to safely operate unmanned aircraft beyond the line of sight anytime day or night.

The Unmanned Vehicle University in Phoenix has opened. This is, so far, the only University in the world licensed to grant Doctorate and Master's Degrees in Unmanned Systems Engineering. Many more Universities now include UAS studies and degree programs, e.g., the University of North Dakota, Kansas State University, Embry-Riddle Aeronautical University, and Indiana Statue University just to name a few.

Remote sensing microsatellites are now operational and in orbit. The Skybox Skysat-1 achieved orbit in November. This satellite, about the size of a small refrigerator, will capture imagery with about 1m GSD. Planet Labs is preparing to launch the largest ever constellation of Earth-imaging satellites later this month. The 28 "Doves" (only 12" by 4" by 4") will be in low orbit (~400 km) beaming 3-5m GSD imagery to earth. Microsatellite customers will be able to purchase and task "fresh" satellite imagery of nearly any location on the planet several times each day using a cell phone.

A very active DIY community, diydrones.com, has developed. There are concept UAVs at Sandia Labs that can fly, swim, drive, and even hop across any terrain. Manned aircraft are being retrofitted with unmanned systems. Indoor positioning is now practical and opens a whole new realm for remote sensing and UAS. Venture capitalists are now actively in the game of funding UAS companies. Lastly, large geospatial firms like Woolpert and Merrick are already performing sUAS services and partnering with UAV providers.

Remote Sensing Gets Personal

"Personal remote sensing" will become very important. Today, only hobbyists are able to do their own remote sensing on the cheap. But UAS technologies will enable a broad swath of citizens and businesses to conduct their own remote sensing with sophistication that is only possible today with large capital

One of the earliest sub-meter GSD images from Skysat-1 now in orbit.

investments. Farmers, orchardists and other high value crop growers, railroads, mining sites, construction companies, journalists, and many citizens will own their own single-purpose, fully automated sUAS. These aircraft will not only fly themselves with a simple upload of flight plans but also deliver geospatial data (orthos, DEMs, NDVI, 3D imagery, etc.) and instructions to their tractors, pesticide sprayers, harvesters, flying cameras, or home PCs, etc.

Within a decade sense and avoid technology will enable larger aircraft to be integrated into the NAS. This “sensing net” around each aircraft, built atop the NextGen air traffic control system now being built, will be instrumental in enabling the efficient and safe operation of manned and unmanned aircraft in the same 3D space. As these robots take to the air, we will see air cargo companies like UPS, FedEx and DHL move freight across the globe in unmanned aircraft. Jeff Bezos' vision of Amazon packages delivered to our doorsteps via UAS will become a reality. Perhaps, unmanned personal air taxis that pick up and deliver riders door-to-door is not a stretch. Imagine the possibilities of "personal air travel" if a small 1-4 person unmanned aircraft could be dispatched to pick you and your date up for ride to a party 90 miles away as easily and inexpensively as today's taxi, and get you there and back more safely than the best driver on today's highways.

Disruptive Innovation

On the dark side of this coming revolution, the innovator's dilemma may doom many of today's "aircraft makers" and remote sensing providers to play virtually no role in manufacturing or operating the millions of next generation UAS. The forces of innovation and brilliance may foster a whole new industry unhindered by the economic models of today's business environment to build, service, finance, insure, and operate UAS. Consider also that sales of traditional piloted aircraft may decline precipitously ... or at least, unmanned systems sales may grow to dwarf anything ever seen with piloted aircraft.

Unmanned, intelligent vehicles will be designed for specific applications and will come in many unconventional shapes and sizes. Imagine everything from specialized long endurance

The Jetsons personal air transports are not unrealistic after sense and avoid technology is available for all UAS.

surveillance craft to swarms of credit-card sized flying "mobile phone cameras" communicating with each other and imaging (in 3D) an agricultural area or the inside of an office building in a few minutes at any resolution. Aircraft design would no longer be constrained to fit the human body. Flying, sensing robots will look like insects, maple seeds, flying credit cards, Frisbees, and 8-rotor vehicles. Things that shouldn't be able to fly will wiz by...maybe a whole swarm!

More specialized and capable unmanned remote sensing platforms will be built. Continual refresh of areas of change will become an "expectation" of users of remotely sensed information. The demand for high resolution data (imagery and elevation) will continue to grow and the price of each pixel and point will fall. Long endurance, persistent surveillance for many types of applications will become a new market for many businesses. Remote sensing in high risk areas like dangerous tidal areas, within hazardous storm systems, in poisonous environments, and near threatening humans and animals will become commonplace and much more affordable.

Specialized vehicles will enable remote sensing companies to task their UAS for other firms based on the vehicles current location. Why fly it back home or leave it on the ground for 2 weeks until the next job if another firm can upload a flight plan and put it to use? These UAS "Zipcars" will provide higher utilization and lower costs. Interestingly, insurance costs for many new "remote sensing" specialists will not be needed since they are no longer operating the remote sensing platform. It remains to be seen if aircraft insurance costs decline for remote sensing platforms that may prove to be more safe and reliable and have no humans on board.

With smaller, specialized remote sensing platforms sensing will become much easier, faster, and economical. Today if 30 flight lines are needed to cover an area, a single manned craft is flown down each flight line, makes wide turns and starts down the next. But with small unmanned "flying cell phones" operators may release thirty out to fly together like a flock of synchronized birds and acquire the entire area in just one strip in 1/10th the time.

Many small and large UAS will not need airports and will be much easier to operate for businesses and individuals.

Many UAS will not need airports. In fact, they will be purposefully designed to avoid them and will safely take off and land virtually anywhere, even from our office rooftops or in our parking lots. Maybe cities will provide safe, lightly administered "landing zones" so UAS use is encouraged and their economic benefit realized.

It is more difficult to envision the other myriad spin off services in the related markets of surveillance or communications. We have only begun to consider the number of problems that can be solved and the possible business opportunities capable of exploiting high resolution data sets of geographic areas inexpensively surveyed repeatedly every hour, day, week, or month?

The NAS as a Platform

As stated earlier, the real take-away from the coming UAS technologies is understanding how the National Air Space will become a “platform” for innovation and business. The NAS platform will have low barriers of entry so any business or individual can safely exploit it to solve problems with significant economic value. Remote sensing and big data about "place" is about to make a quantum leap forward because of this "NAS platform".

As ubiquitous remote sensing becomes possible why wouldn't Google or Microsoft market the near real-time updates to every city and county, and to pipeline, mining, and utility companies in exchange for the use of this data in their "globe" products. They could become the source of "engineering scale" remote sensing data for a large portion of today's markets. Microsoft has already engaged in this type of effort albeit to a much smaller scale and at considerably higher cost via the Clear30 program. UAS will only make this more practical and economical.

Advocacy Needed

Regulation is still a real threat and the biggest constraint to the adoption of this transformative technology. Always the optimist, it is more likely that the powerful economic forces inherent with this enabling technology will pressure the social and political forces to get out of the way.

Many anti-UAS privacy advocates today want us to envision a future of dark, stealthy, armed birds of prey circling over every American city ready to infringe on all. This type of alarmist rhetoric is consistent with the introduction of disruptive technology in society. It has happened many times in the past. People fear the "worst". Our growing distrust of a powerful and increasingly inept government feeds this fear of repressive security measures.

Unwise, choking regulations remain an important threat to the economic potential of UAS.

Although that vision is ridiculous, geospatial professionals are advised not ignore these concerns and instead should address them head on. Professionals need to counter this view by advocacy in public policy and with the adoption and promotion of safe, responsible UAS use. We need to foster transparent data collection and honest data minimization standards that ensure private data is not collected, or when it is collect, how and when it will be destroyed or anonymized.

Data is power. UAS operators will have sensors and sensor networks with tremendous data acquisition, synthesis and analysis capabilities. The public will need to see our profession use this technology responsibly and understand that their privacy is credibly safeguarded. As Bruce Schneier says "Data is the pollution problem of the information age." The threat to personal privacy of this "pollution" is real because of the technology's growing relevance and ubiquity.

The number of new opportunities in the coming UAS economy is breathtaking. There remain many regulatory obstacles that threaten the robust maturation of this disruptive technology. There will be winners and losers among geospatial and remote sensing firms. Existing providers can remain relevant, but they must profitably transition to the new paradigm and leverage the "NAS platform" to extract new value from points and pixels. The best firms will recognize and capitalize on the many new opportunities made possible by the NAS platform of UAS.

ORIGINALLY PUBLISHED

- Sensors & Systems / December 23, 2013
- Mike Tully, CEO of Aerial Services / Author

Approaching the Age of Personal Remote Sensing

For the geospatial and remote sensing professions, unmanned aircraft systems (UASs) represent the most significant onslaught of enabling technology since the first camera took flight 150 years ago. When UAS technology is combined with virtual unrestricted access to the U.S. national airspace system (NAS) for anyone and any business—think "personal remote sensing"—the repercussions for our culture and economy will grow by orders of magnitude. The influence of UAS technology will be felt in nearly every major area of commerce.

Personal UASs, such as the ready-to-fly Phantom 2 Vision quadcopter, allow users to capture the world around them like never before.

Key Developments

Miniaturization, location and wireless communication technologies have conspired to enable pilotless and remotely piloted sensor nets to safely crisscross the U.S. national airspace unlike ever before. UASs will perform an unprecedented amount of remote sensing and surveillance work that has the potential to saturate the country with many benefits.

UASs will come in all shapes and sizes, and they'll be designed for myriad uses—most of which haven't even been considered. During the next 1-5 years, the Federal Aviation Administration (FAA) is expected to let small UASs (< 55lbs) fly in certain unpopulated areas for commercial purposes much lower than civil or commercial aircraft. The agency recently selected six UAS research and test site operators across the country to investigate future UAS use.

Most analysts believe the agriculture, real estate and emergency management markets will be among the first to benefit. Once a notice of proposed rulemaking is released, possibly this year, personal and commercial interests could take to the skies like a nest of disturbed hornets.

Unlike other "incremental" technologies that came before UASs, such as digital cameras, light detection and ranging (LiDAR) technology and softcopy photogrammetry, UAS technology will become a great enabler for the masses to perform remote sensing and mapping because it opens the NAS to so many people. This is the revolutionary aspect of UAS technology and why it will impact society and culture so significantly. Assuming policy doesn't throttle such advances, it isn't difficult to envision a reality where virtually anyone, anytime, anywhere could perform remote sensing.

Related Advances

The same technologies of miniaturization, location and wireless communication also have enabled a new species of bird in the air called "microsatellites," which will play a similar role as UASs in geospatial and remote sensing. For example, the Dove series of microsatellites launched by San Francisco-based Planet Labs (www.planet-labs.com) is in service today above the NAS to photograph most of Earth several times each day at low resolution. Similarly, Mountain View, Calif.-based Skybox Imaging (www.skyboximaging.com) offers sub-meter color and near-infrared imagery from its new SkySat-1 microsatellite.

NASA's Dryden Flight Research Center at Edwards Air Force Base, Calif., is investigating ways to help integrate UASs into the world around us.

Microsatellite ventures are well funded because investors see great value in the geographic reach, currency, resolution and price of this remotely sensed information. Consider how such imagery will benefit thousands of small businesses that desire to leverage global, near-instant geospatial information. The Doves are only the first "flock" of inexpensive, on-demand, global remote sensing satellites to take flight. Many other microsatellites with increasing resolution will be buzzing over the globe in the next few years, providing unprecedented quantities of visual—and eventually 3-D—information.

Virtual reality is another important new technology aligning well with UAS technology. Oculus Rift headsets, developed by Oculas VR (www.oculusvr.com), Irvine, Calif., are set to make a big impact in our lives and work. The combination of UAS technology and inexpensive, realistic virtual reality will further open the 3-D world for the common person as never before. Anyone could "climb aboard" a small UAS and tour the Grand Canyon—even remotely pilot the vehicle and fly wherever they want within a "geofence" imposed by the provider. Virtual reality technology has the potential to redefine human experience and will almost

certainly be strapped to UAS vehicles to provide the masses with views from above that have been impossible—or at least uncommon—to date.

Looking Ahead

Soon a network of tiny, flying sensors will allow us to unlock amazing wildlife secrets, gain insights on violent weather events, and learn about climate, air pollution, migrations, human activity and hundreds of other applications. For the first time, the common person and ordinary business will be able to access the NAS recreationally and commercially. Today, except for the few pilots among us, few people have 3-D access to the real world outside of passively sitting inside a commercial airliner.

The boon of personal remote sensing for business, science and recreation is hard to overstate. Certainly there are legitimate privacy concerns that UAS purveyors and users must address responsibly and professionally.

Following the successful launch of its Dove 3 and Dove 4 microsatellites in late 2013, Planet Labs recently delivered a fleet of 28 Earth-imaging satellites to the NASA Wallops Flight Facility for a 2014 launch.

Never–theless, access to the skies over our heads is about to explode. UASs, microsatellites and virtual reality will transform NAS access for the masses. Personal remote sensing by large numbers of individuals and businesses will become routine and common.

ORIGINALLY PUBLISHED

- Earth Imaging Journal / 2014
- Mike Tully, CEO of Aerial Services / Author

DRONES … There. I said it!

Drones. Drones. Drones. There! I said it. DRONES. As a member of the remote sensing and geospatial community I'm not to use this "bad" word. It arouses terrible images in peoples' minds. Supposedly, when people hear drone, they picture missile-laden, all-knowing, killing machines blasting innocents from their chairs at Starbucks. Or, that privacy-sucking techno-aphids are sucking the life out of our society by recording everything we do and everywhere we go. Our privacy has been (or soon will be) sacrificed on the altar to the drones.

Well, it's time we take back this word. Drone … It's beautiful. It rolls off the tongue easily. It's easy to spell. It has a long, storied history with our culture from science fiction and movies. It's like Kodak. Memorable. Easy to remember. Impossible to misspell. It communicates effortlessly. Our culture has always loved this word because of the romance and wonder associated with the technology that would be so cool someday.

Well, that day is here. The tech is real. We have planes, trains, and automobiles (and boats) capable of driving themselves …. And they promise to bring a boat-load of social, economic, and individual good around the planet. Drones (I said it again) will bring life-saving help and medicines to people hurt by disasters and crime. Drones will bring life to road-less areas around the planet. Drones will help farmers use less fertilizer and pesticides. Our environment will call back "Thank you, drones". Our forests, roads, rails, and power lines will be better maintained and protected at less cost using Drones. Instead of getting aerial imagery every 3-5 years for your city or county, they will get them

inexpensively whenever they want, as often as they want. Thank you, drones.

Drones are beautiful. They are a monument to inventiveness. Today they look and move like insects, bugs, fish, humans, cars, helicopters, planes, Frisbees, balls. They come in all sizes and shapes. They have a wide variety of specializations. Ag drones. Home drones. Personal drones. Amazon drones. Journalist drones. Mapping drones. Game drones. Beer drones. They see, smell, hear, measure, morph, and tell. All this sci-fi stuff is only just getting started!

Are there down sides to drones? The short answer is: No. The more nuanced answer is: Yes … there are certainly down sides to how some humans may choose to use, misuse, and abuse drone. But how does this differ from any other technology: think the internet, the mobile phone, the camera, the satellite, the microphone? There will always be nefarious people, organizations, and governments that use great tech for bad stuff. Is our privacy threatened by the wrongful use of drones? Yes. But it is threatened far more by the Internet, the mobile device, and (you name it). If concerned about privacy, don't look up for drones, look in your pocket at your cell phone. Go ahead and don your stupid anti-drone clothing. If worried about the loss of confidentiality, look to your computer for email taps. If worried about Big Brother, look to our government for excessive NSA spying. But the fact that privacy could be compromised by

drones should not detract from the amazing good that has come from this tech and will come from the application of drones to commercial and social pursuits. It is up to us in this nation of laws with constitutional protections of liberty to ensure that great tech is used for great good and its improper application is marginalized.

So, drone on. I fly drones. Drones are great! Let's reclaim this term and restore its place in our nation's vocabulary and ethos to one of benefit, wonder, and great good.

ORIGINALLY PUBLISHED

- Point of Beginning / March 18, 2014
- Mike Tully, CEO of Aerial Services / Author

Chapter 4

Appendix

- Unmanned Aerial System (UAS) Survey
- FAA 2012 Modernization Bill - UAS Provisions
- State Laws & Regulations

"A Scan Eagle UAV is launched from USS Gunston Hall," by Official U.S. Navy Page, Some Rights Reserved http://bit.ly/1mwWk8Z

Unmanned Aerial System (UAS) Survey

Aerial Services completed this market survey of existing Unmanned Aerial Systems (UAS) in September 2012. It contains well over 150 different models of UAS and dozens of UAS-sized sensors and photogrammetric software from all over the world. The products listed here are intended primarily for civil use.

This information illustrates the diversity of unmanned aerial systems and, with time, will record just how quickly this market is changing and maturing. The main utility of this information will be to quickly discover the plethora of available options for Unmanned Aerial Systems useful for creating geospatial information and services. Today's major players in each of these market segments are easily identified.

This database is not complete. Not only is this market rapidly developing with different products being offered and retired each week, but no attempt was made to include those UAS used primarily for military purposes or those marketed only in foreign countries.

Aerial Services would like to acknowledge the Iowa Space Grant Consortium (ISGC) for making this market survey possible. Intern Garrett Ramthum, funded by ISGC completed much of this work while working at Aerial Services.

ORIGINALLY PUBLISHED

- Aerial Services, Inc. (ASI) / December 10, 2012
- Garrett Ramthum, Iowa Space Grant Consortium (ISGC) Intern at Aerial Services / Author

FAA 2012 Modernization Bill - UAS Provisions

On 14 February 2012 the President signed the FAA Modernization and Reform Act of 2012 into law. Among other things, this required the FAA to establish a plan by 2015 for the integration of unmanned aerial systems into the National Airspace. "Subtitle B" listed below is the relevant portion of the entire bill that pertains to UAS.

SUBTITLE B—UNMANNED AIRCRAFT SYSTEMS DEFINITIONS

FAA Modernization and Reform Act of 2012

Public Law 112–95 112th Congress An Act

February 14, 2012

To amend title 49, United States Code, to authorize appropriations for the Federal Aviation Administration for fiscal years 2011 through 2014, to streamline programs, create efficiencies, reduce waste, and improve aviation safety and capacity, to provide stable funding for the national aviation system, and for other purposes.

Table of Contents (Subtitle B)

Subtitle B—Unmanned Aircraft Systems

SEC. 331. DEFINITIONS.

In this subtitle, the following definitions apply:

(1) ARCTIC.—The term "Arctic'' means the United States zone of the Chukchi Sea, Beaufort Sea, and Bering Sea north of the Aleutian chain.

(2) CERTIFICATE OF WAIVER; CERTIFICATE OF AUTHORIZATION.—The terms "certificate of waiver'' and "certificate of authorization'' mean a Federal Aviation Administration grant of approval for a specific flight operation.

(3) PERMANENT AREAS.—The term "permanent areas'' means areas on land or water that provide for launch, recovery, and operation of small unmanned aircraft.

(4) PUBLIC UNMANNED AIRCRAFT SYSTEM.—The term "public unmanned aircraft system'' means an unmanned aircraft system that meets the qualifications and conditions required for operation of a public aircraft (as defined in section 40102 of title 49, United States Code).

(5) SENSE AND AVOID CAPABILITY.—The term "sense and avoid capability'' means the capability of an unmanned aircraft to remain a safe distance from and to avoid collisions with other airborne aircraft.

(6) SMALL UNMANNED AIRCRAFT.—The term "small unmanned aircraft'' means an unmanned aircraft weighing less than 55 pounds.

(7) TEST RANGE.—The term "test range'' means a defined geographic area where research and development are conducted.

(8) UNMANNED AIRCRAFT.—The term "unmanned aircraft'' means an aircraft that is operated without the possibility of direct human intervention from within or on the aircraft.

(9) UNMANNED AIRCRAFT SYSTEM.—The term "unmanned aircraft system'' means an unmanned aircraft and associated elements (including communication links and the components that control the unmanned aircraft) that are required for the pilot in command to operate safely and efficiently in the national airspace system.

SEC. 332. INTEGRATION OF CIVIL UNMANNED AIRCRAFT SYSTEMS INTO NATIONAL AIRSPACE SYSTEM.

(a) REQUIRED PLANNING FOR INTEGRATION.—

(1) COMPREHENSIVE PLAN.—Not later than 270 days after the date of enactment of this Act, the Secretary of Transportation, in consultation with representatives of the aviation industry, Federal

agencies that employ unmanned aircraft systems technology in the national airspace system, and the unmanned aircraft systems industry, shall develop a comprehensive plan to safely accelerate the integration of civil unmanned aircraft systems into the national airspace system.

(2) CONTENTS OF PLAN.—The plan required under paragraph (1) shall contain, at a minimum, recommendations or projections on —

(A) the rulemaking to be conducted under subsection (b), with specific recommendations on how the rulemaking will—

(i) define the acceptable standards for operation and certification of civil unmanned aircraft systems;

(ii) ensure that any civil unmanned aircraft system includes a sense and avoid capability; and

(iii) establish standards and requirements for the operator and pilot of a civil unmanned aircraft system, including standards and requirements for registration and licensing;

(B) the best methods to enhance the technologies and subsystems necessary to achieve the safe and routine operation of civil unmanned aircraft systems in the national airspace system;

(C) a phased-in approach to the integration of civil unmanned aircraft systems into the national airspace system;

(D) a timeline for the phased-in approach described under subparagraph (C);

(E) creation of a safe

(F) airspace designation for cooperative manned and unmanned flight operations in the national airspace system;

(G) establishment of a process to develop certification, flight standards, and air traffic requirements for civil unmanned aircraft systems at test ranges where such systems are subject to testing;

(H) the best methods to ensure the safe operation of civil unmanned aircraft systems and public unmanned aircraft systems simultaneously in the national airspace system; and

(I) incorporation of the plan into the annual NextGen Implementation Plan document (or any successor document) of the Federal Aviation Administration.

(3) DEADLINE.—The plan required under paragraph (1) shall provide for the safe integration of civil unmanned aircraft systems into the national airspace system as soon as practicable, but not later than September 30, 2015.

(4) REPORT TO CONGRESS.—Not later than 1 year after the date of enactment of this Act, the Secretary shall submit to Congress a copy of the plan required under paragraph

(5) ROADMAP.—Not later than 1 year after the date of enactment of this Act, the Secretary shall approve and make available in print and on the Administration's Internet Web site a 5-year roadmap for the introduction of civil unmanned aircraft systems into the national airspace system, as coordinated by the Unmanned Aircraft Program Office of the Administration. The Secretary shall update the roadmap annually.

(b) RULEMAKING.—Not later than 18 months after the date on which the plan required under subsection (a)(1) is submitted to Congress under subsection (a)(4), the Secretary shall publish in the Federal Register—

(1) a final rule on small unmanned aircraft systems that will allow for civil operation of such systems in the national airspace system, to the extent the systems do not meet the requirements for expedited operational authorization under section 333 of this Act;

(2) a notice of proposed rulemaking to implement the recommendations of the plan required under subsection (a)(1), with the final rule to be published not later than 16 months after the date of publication of the notice; and

(3) an update to the Administration's most recent policy statement on unmanned aircraft systems, contained in Docket No. FAA–2006–25714.

(c) PILOT PROJECTS.—

(1) ESTABLISHMENT.—Not later than 180 days after the date of enactment of this Act, the Administrator shall establish a program to integrate unmanned aircraft systems into the national airspace system at 6 test ranges. The program shall terminate 5 years after the date of enactment of this Act.

(2) PROGRAM REQUIREMENTS.—In establishing the program under paragraph (1), the Administrator shall—

(A) safely designate airspace for integrated manned and unmanned flight operations in the national airspace system;

(B) develop certification standards and air traffic requirements for unmanned flight operations at test ranges;

(C) coordinate with and leverage the resources of the National Aeronautics and Space Administration and the Department of Defense;

(D) address both civil and public unmanned aircraft systems;

(E) ensure that the program is coordinated with the Next Generation Air Transportation System; and

(F) provide for verification of the safety of unmanned aircraft systems and related navigation procedures before integration into the national airspace system.

(3) TEST RANGE LOCATIONS.—In determining the location of the 6 test ranges of the program under paragraph (1), the Administrator shall—

(A) take into consideration geographic and climatic diversity;

(B) take into consideration the location of ground infrastructure and research needs; and

(C) consult with the National Aeronautics and Space Administration and the Department of Defense. Consultation.

(4) TEST RANGE OPERATION.—A project at a test range shall be operational not later than 180 days after the date on which the project is established.

(5) REPORT TO CONGRESS.—

(A) IN GENERAL.—Not later than 90 days after the date of the termination of the program under paragraph (1), the Administrator shall submit to the Committee on Commerce, Science, and Transportation of the Senate and the Committee on Transportation and Infrastructure and the Committee on Science, Space, and Technology of the House of Representatives a report setting forth the Administrator's findings and conclusions concerning the projects.

(B) ADDITIONAL CONTENTS.—The report under subparagraph (A) shall include a description and assessment of the progress being made in establishing special use airspace to fill the immediate need of the Department of Defense—

(i) to develop detection techniques for small unmanned aircraft systems; and

(ii) to validate the sense and avoid capability and operation of unmanned aircraft systems.

(d) EXPANDING USE OF UNMANNED AIRCRAFT SYSTEMS IN ARCTIC.—

(1) IN GENERAL.—Not later than 180 days after the date of enactment of this Act, the Secretary shall develop a plan and initiate a process to work with relevant Federal agencies and national and international communities to designate permanent areas in the Arctic where small unmanned aircraft may operate 24 hours per day for research and commercial purposes. The plan for operations in these permanent areas shall include the development of processes to facilitate the safe operation of unmanned aircraft beyond line of sight. Such areas shall enable over-water flights from the surface to at least 2,000 feet in altitude, with ingress and egress routes from selected coastal launch sites.

(2) AGREEMENTS.—To implement the plan under paragraph (1), the Secretary may enter into an agreement with relevant national and international communities.

(3) AIRCRAFT APPROVAL.—Not later than 1 year after the entry into force of an agreement necessary to effectuate the purposes of this subsection, the Secretary shall work with relevant national and international communities to establish and implement a process, or may apply an applicable process already established, for approving the use of unmanned aircraft in the designated permanent areas in the Arctic without regard to whether an unmanned aircraft is used as a public aircraft, a civil aircraft, or a model aircraft.

SEC. 333. SPECIAL RULES FOR CERTAIN UNMANNED AIRCRAFT SYSTEMS.

(a) IN GENERAL.—Notwithstanding any other requirement of this subtitle, and not later than 180 days after the date of enactment of this Act, the Secretary of Transportation shall determine if certain unmanned aircraft systems may operate safely in the national airspace system before completion of the plan and rule-making required by section 332 of this Act or the guidance required by section 334 of this Act.

(b) ASSESSMENT OF UNMANNED AIRCRAFT SYSTEMS.—In making the determination under subsection (a), the Secretary shall determine, at a minimum—

(1) which types of unmanned aircraft systems, if any, as a result of their size, weight, speed, operational capability, proximity to airports and populated areas, and operation within visual line of sight do not create a hazard to users of the national airspace system or the public or pose a threat to national security; and

(2) whether a certificate of waiver, certificate of authorization, or airworthiness certification under section 44704 of title 49, United States Code, is required for the operation of unmanned aircraft systems identified under paragraph (1).

(c) REQUIREMENTS FOR SAFE OPERATION.—If the Secretary determines under this section that certain unmanned aircraft systems may operate safely in the national airspace system, the Secretary shall establish requirements for the safe operation of such aircraft systems in the national airspace system.

SEC. 334. PUBLIC UNMANNED AIRCRAFT SYSTEMS.

(a) GUIDANCE.—Not later than 270 days after the date of enactment of this Act, the Secretary of Transportation shall issue guidance regarding the operation of public unmanned aircraft systems to—

(1) expedite the issuance of a certificate of authorization process;

(2) provide for a collaborative process with public agencies to allow for an incremental expansion of access to the national airspace system as technology matures and the necessary safety

analysis and data become available, and until standards are completed and technology issues are resolved;

(3) facilitate the capability of public agencies to develop and use test ranges, subject to operating restrictions required by the Federal Aviation Administration, to test and operate unmanned aircraft systems; and

(4) provide guidance on a public entity's responsibility when operating an unmanned aircraft without a civil airworthiness certificate issued by the Administration.

(b) STANDARDS FOR OPERATION AND CERTIFICATION.—Not later than December 31, 2015, the Administrator shall develop and implement operational and certification requirements for the operation of public unmanned aircraft systems in the national airspace system.

(c) AGREEMENTS WITH GOVERNMENT AGENCIES.—

(1) IN GENERAL.—Not later than 90 days after the date of enactment of this Act, the Secretary shall enter into agreements with appropriate government agencies to simplify the process for issuing certificates of waiver or authorization with respect to applications seeking authorization to operate public unmanned aircraft systems in the national airspace system.

(2) CONTENTS.—The agreements shall—

(A) with respect to an application described in paragraph (1)—

(i) provide for an expedited review of the application;

(ii) require a decision by the Administrator on approval or disapproval within 60 business days of the date of submission of the application; and

(iii) allow for an expedited appeal if the application is disapproved;

(B) allow for a one-time approval of similar operations carried out during a fixed period of time; and

(C) allow a government public safety agency to operate unmanned aircraft weighing 4.4 pounds or less, if operated—

(i) within the line of sight of the operator;

(ii) less than 400 feet above the ground;

(iii) during daylight conditions;

(iv) within Class G airspace; and

(v) outside of 5 statute miles from any airport, heliport, seaplane base, spaceport, or other location with aviation activities.

SEC. 335. SAFETY STUDIES.

The Administrator of the Federal Aviation Administration shall carry out all safety studies necessary to support the integration of unmanned aircraft systems into the national airspace system.

SEC. 336. SPECIAL RULE FOR MODEL AIRCRAFT.

IN GENERAL.—Notwithstanding any other provision of law relating to the incorporation of unmanned aircraft systems into Federal Aviation Administration plans and policies, including this subtitle, the Administrator of the Federal Aviation Administration may not promulgate any rule or regulation regarding a model aircraft, or an aircraft being developed as a model aircraft, if—

(1) the aircraft is flown strictly for hobby or recreational use;

(2) the aircraft is operated in accordance with a community-based set of safety guidelines and within the programming of a nationwide community-based organization;

(3) the aircraft is limited to not more than 55 pounds unless otherwise certified through a design, construction, inspection, flight test, and operational safety program administered by a community-based organization;

(4) the aircraft is operated in a manner that does not interfere with and gives way to any manned aircraft; and

(5) when flown within 5 miles of an airport, the operator of the aircraft provides the airport operator and the airport air traffic control tower (when an air traffic facility is located at the airport) with prior notice of the operation (model aircraft operators flying from a permanent location within 5 miles of an airport should establish a mutually-agreed upon operating procedure with the airport operator and the airport air traffic control tower (when an air traffic facility is located at the airport)).

(b) STATUTORY CONSTRUCTION.—Nothing in this section shall be construed to limit the authority of the Administrator to pursue enforcement action against persons operating model aircraft who endanger the safety of the national airspace system.

(c) MODEL AIRCRAFT DEFINED.—In this section, the term "model aircraft'' means an unmanned aircraft that is—

(1) capable of sustained flight in the atmosphere;

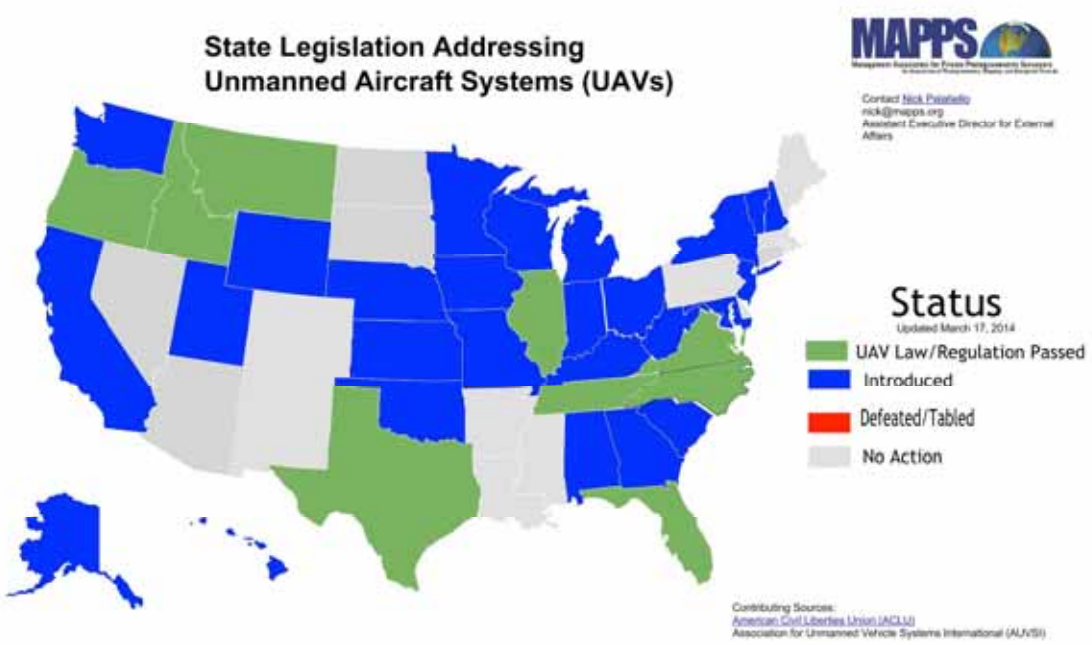
(2) flown within visual line of sight of the person operating the aircraft; and

(3) flown for hobby or recreational purposes.

State Laws & Regulations

Since the FAA Modernization and Reform Act of 2012 was passed there has continued to be a flurry of legislative activity occurring at the Federal and State levels. At the date of this writing, the FAA has missed nearly every deadline mandated by this bill, and since releasing the UAS Roadmap in Dec 2013, they have admitted that they do not anticipate allowing commercial use of UAS in 2015 but will merely have a plan for how they will someday allow commercial use.

In the absence of clear direction from the FAA or Congress there is a growing "black market" of entrepreneurs that are using small UAS for commercial pursuits. So great is this pent up desire for commercial use of sUAS that there is growing political pressure to accelerate the regulatory process and so establish clear guidelines as soon as possible.



Added to this soup of regulatory uncertainty, many states legislatures are discussing or have already passed laws that regulate the use of sUAS. This hodge-podge of varying laws among the States will only add to the frustration and confusion prevalent in the sUAS industry today. This map shows the current smorgasbord of state laws in the mix and changes virtually every day.

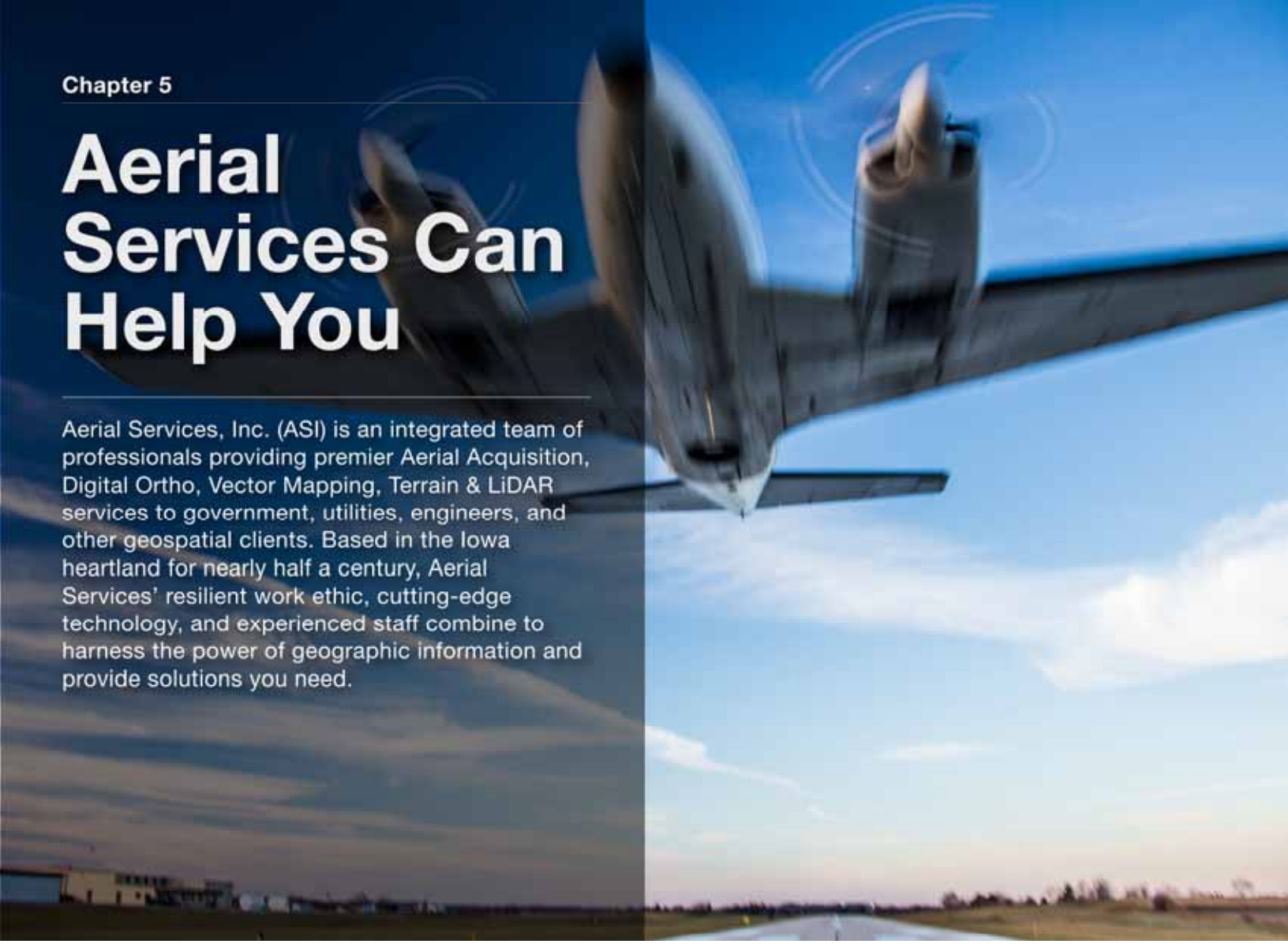
Further compounding this regulatory morass, the FAA continues to demand commercial users stop their activities; and they often intervene to force the issue. In one highly publicized case in 2011, they fined one user, Raphael Pirker, who has since gone on to successfully challenge the FAA in court that they lack the authority to impose such fines (PDF). An Administrative Law Judge with the NTSB struck down that fine and sided with Pirker in March 2014. Since that time, the FAA has appealed the ruling and the Judge has stayed the decision. So once again, the budding commercial UAS industry is put on an uncertain, nervous hold until further clarity is elicited from somewhere ... anywhere.

It seems probable that the FAA will face additional legal challenges as the pressure to establish rules for sUAS builds. It is equally likely that, in face of further delays of sUAS commercial operational rules, the "black market" for such use will become impossible to contain. In that scenario the threat to the safety of the National Airspace clearly becomes a concern.

Chapter 5

Aerial Services Can Help You

Aerial Services, Inc. (ASI) is an integrated team of professionals providing premier Aerial Acquisition, Digital Ortho, Vector Mapping, Terrain & LiDAR services to government, utilities, engineers, and other geospatial clients. Based in the Iowa heartland for nearly half a century, Aerial Services' resilient work ethic, cutting-edge technology, and experienced staff combine to harness the power of geographic information and provide solutions you need.



A Trusted Geospatial Provider

Aerial Services, Inc. (ASI) is an established provider of customized geospatial solutions.

- They will **exceed your expectations** while delivering on promises
- Their experience with and mastery of emerging technology ensures your project is **accurate, on-time, and within budget**
- Their **hard-working staff** of professional photogrammetrists, surveyors, computer professionals, GIS specialists, aerial photographers, and pilots are among the best at developing geospatial services
- Many employees have been with the company for **decades**
- Located in the charming Midwestern town of Cedar Falls, Iowa Aerial Services has become a **trusted provider** of geospatial solutions, allowing them to provide all of the services of the large geospatial providers with the attention to detail and personal service of smaller operations.

Solutions

Geosolutions are seamlessly integrated and focused on the critical needs of Aerial Services' customers. We have both standard and custom solutions with foundations in providing excellent value, timely provision of geoknowledge and the ultimate in quality.

Customizable Options For:

- Oil & Gas
- Aggregate & Mining
- Roadway
- Electrical Utility
- Precision Farming
- Resource Management
- Forestry
- Land Management
- Railway

Technology

- Imagery
- LiDAR
- Photogrammetry
- Video
- Metadata
- Penetrating Radar

Visualizations

- Fly Throughs
- Industry Standard
- GIS Files
- GeoPDF
- Paper Maps / Posters

eDelivery

- Hard Drive or USB
- FTP Download
- Web Services

eSolutions

- Spatial Cloud
- eDocs

Accuracy

- GIS Grade
- Engineering Grade

Contact Now

Contact Aerial Services' Geospatial Solutions Managers to consult on your specific project needs today.

Call - (319) 277-0436
Email - Inquiries@AerialServicesInc.com
Visit - www.AerialServicesInc.com

Enews For You

Enewsletter is your place to stay up-to-date

Aerial Services, Inc. (ASI), an integrated team of professionals providing premier Aerial Acquisition, Digital Ortho, Vector Mapping, Terrain & LiDAR services, sends this e-newsletter quarterly to clients, colleagues, and friends. Thanks for subscribing. You can also follow Aerial Services via your favorite social media outlets.

Enjoy and stay in touch!

"Geospatial Mapping Applications Using UAVs" webinar hosted by AUVSI/MAPPS featured Aerial Services' Mike Tully

On Wednesday, December 18, 2013, 3:00 PM (Eastern), AUVSI and MAPPS are hosting special webinar to discuss "Geospatial Mapping Applications Using UAVs". This event will include remarks from Mike Tully, Aerial Services President & CEO, an acknowledged thought leader in the UAS for geospatial discussion.

Learn more & register...

Fall Webinars' Recording & Slides

Aerial Services, Inc. (ASI) has completed their fall 2013 webinar series. These educationally driven, one-hour events discussed a number of geospatial topics and are free to those interested via recorded video/slides. Each is hosted by Aerial Services

asi

Volume 7, Issue 4
December 2013

Your Subscription Information

Name: Aerial Services
Company: Company Name
City: Cedar Falls, Iowa
Email: marketing@aerialservicesinc.com

Upcoming Project? Get a free Consultation

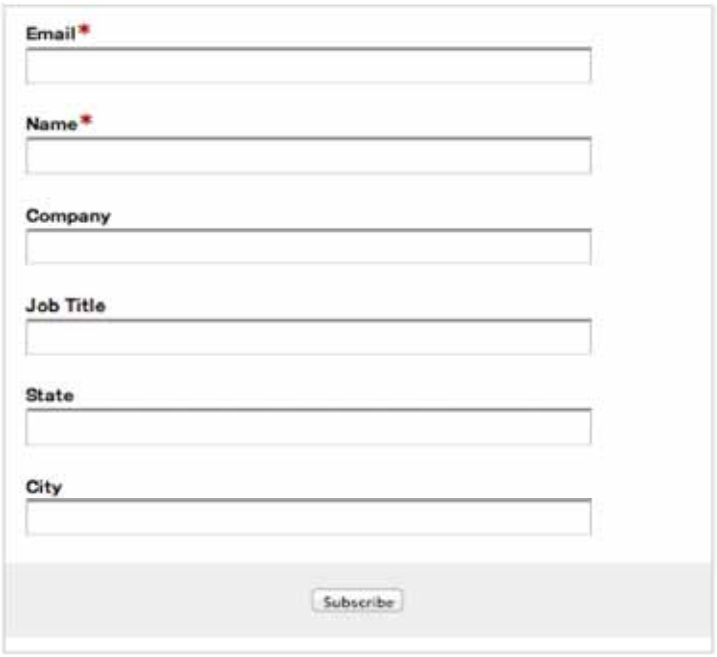
Aerial Services' experts are here to help. Contact them today regarding your next project and they'll provide no-hassle advice and, if desired, a project quote.

To get started today, email them or call (319) 277-0436.

Connect & Share

Established in 2007, the **Aerial Services Enewsletter** has a loyal following of thousands of friends of Aerial Services who want to stay on top of developing trends, tech, and opinion regarding the remote-sensing profession.

Free Enewsletter Signup



Email*

Name*

Company

Job Title

State

City

Subscribe

- * Starred items required, others are optional.
- You may unsubscribe at anytime via an easy unsubscribe link.
- Aerial Services respects your inbox and does not spam.

The Enewsletter is released **once per quarter** with news, reviews, and opinion regarding the geospatial profession.

All are welcome to sign-up for free via the form on the right