

Unmanned Aircraft Systems (UAS)

The current and potential uses of UAS, also commonly referred to as drones, Unmanned Aerial Vehicles (UAV), or Remotely Piloted Aircraft (RPA), and even model aircraft, are evolving more rapidly than the laws and regulations that govern them. Daily, drone use, and all too often drone misuse, is prominently featured in local and national news headlines and across social media. Their increased prevalence and publicity is expected to continue over the next several years. Without a doubt, drone use has the potential to change how Minnesotans conduct business, move goods, and access the nation's airspace. However, this great potential is not without significant challenges. This paper focuses on how UAS are being used and regulated today and what we might expect in the future. It also discusses the associated issues and risks proliferation of UAS present.

RAPID EVOLUTION

The term UAS is used to cover a broad range of aircraft that are becoming more readily available via the internet and in local retail stores such as RadioShack, Best Buy, and even Menards. It is important to understand that the Federal Aviation Administration's (FAA) definition of UAS is not limited to the aircraft that is being flown, but to all the components necessary to support the aerial operation, such as support equipment and controls, and the human operator, are all considered part of an UAS.

Figure 1: UAS quadcopter in operation¹



Drones are becoming increasingly available in a broad range of sizes designed to perform an equally wide range of tasks and functions. Some micro-sized drones being developed have the potential to operate nearly undetected in close proximity to unsuspecting persons on the ground while other, more commonly recognized models (see photo above), are relatively easy to see when operated in close proximity. Despite being more visible, these drones could still pose a safety threat to people on the ground and manned aircraft in the sky. Just five years ago, military UAS were likely what most Minnesotans associated with the term and likely in the context of military activities halfway around the world. While UAS are still routinely utilized in military operations, commercial and recreational uses have eclipsed military use. A sample of the current and emerging UAS uses and users include those listed below.

¹ David Gonzalez, MnDOT

Typical UAS Uses

- Precision agriculture
- Infrastructure inspection
- Mail/package deliver
- Border patrol
- Remote sensing
- Surveying & mapping
- Film making
- Disaster Response
- Firefighting
- Law enforcement
- Medical supply delivery
- Research & development

Typical UAS Users

- Farmers
- Film makers
- Government agencies
- Hobbyists
- Law enforcement agencies
- Manufacturing & other industry
- Public utilities
- Realtors
- Universities

The availability and use of UAS are on the rise largely due to rapid advances in the underlying technology needed to manufacture the vehicles and downward trending price point. UAS sales have increased more rapidly than anticipated just a few years ago. As recently as 2010, the FAA estimated that 15,000 UAS would be in operation in the United States by 2020.² Today, estimated UAS sales exceed 15,000 each month; the FAA estimated that one million drones were sold during the 2015 holiday season, mostly for hobbyist use.³ The FAA confirmed that over 300,000 recreational UAS users registered as of the end of January 2016. This represents an exponential increase in the use of the National Airspace System (NAS), in addition to a significant increase in the number of "pilots" using the system. Many of the new UAS operators, or pilots, are not adequately prepared to operate an aircraft in the NAS. The 'Know Before You Fly' education campaign was established to spread the word about what constitutes safe and responsible small UAS flying, especially for model or recreational UAS operators who may not be licensed pilots. Adequate preparation for commercial small UAS operation is different and discussed below.

BUSINESS APPLICATIONS AND ECONOMIC IMPACT

Today, UAS are increasingly used for a variety of commercial purposes to achieve a broad range of goals and tasks. This trend is driven in part by the potential to save money, time, and lives. Commercial use of drones will have a profound and undeniable impact on state, national, and global economies. Notably, a 2013 report by the Association for Unmanned Vehicle Systems International (AUVSI) estimated that from 2015 to 2017 more than 70,000 jobs would be created in the United States directly resulting from the drone industry with a national economic impact of more than \$13.6 billion.⁴

To use UAS for commercial or business purposes today, an operator must obtain permission from the FAA. Any aircraft operation in the NAS requires a certificated and registered aircraft, a licensed pilot, and operational approval.

A process known as a Section 333 Exemption provides commercial operators who wish to pursue safe and legal entry into the NAS a competitive advantage in the UAS marketplace, thus discouraging illegal operations and improving safety, according to the FAA. This process of exempting specific uses from certain federal requirements and thus allowing legal commercial drone use has been established as an interim procedure until more complete rules can be formally adopted. All Section 333 exemptions are issued with conditions and limitations when the operator is responsible

² [Karp, 2015](#)

³ [Addady, 2015](#)

⁴ [Association for Unmanned Aerial Systems International, 2013](#)

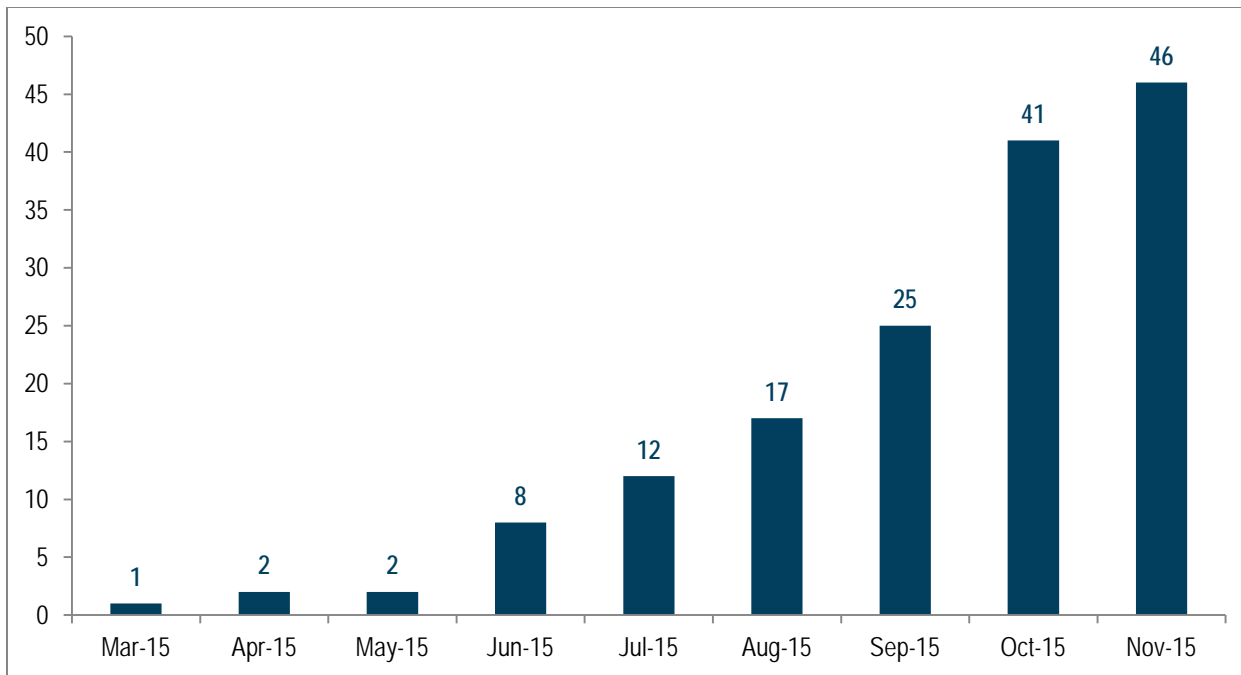
for compliance. Currently, a petitioner requesting a Section 333 exemption is advised to make the request 120 days prior to the date they anticipate operations.

In addition to obtaining a Section 333 exemption, a Certificate of Waiver or Authorization (COA) is also needed. The FAA is currently issuing a 'blanket' COA for UAS operations (e.g. photography/filmmaking and real estate purposes) below 200 feet. If an operator intends to fly higher or operate in an unauthorized way, a special COA must be obtained.

UAS commercial operations are required to have 'N-numbers,' a unique number identifying civil aircraft, just like manned aircraft. In Minnesota, there are currently 34 UAS with N-numbers, which are also required to be registered with the state and obtain a commercial operator's license.

The rapid growth in commercial UAS use is illustrated by the number of Section 333 Exemption approvals over time, as displayed in the chart below (Figure 2) for Minnesota.

Figure 2: Section 333 Exemptions Completed - Minnesota^{5,6}



The remainder of this section provides additional context around some of the most promising commercial UAS uses.

Agriculture

Drones are increasingly being used in the precise application of fertilizers, pesticides, and water. To that end, in May 2015, the FAA approved use of a UAS that had been tested and used for crop spraying in Japanese rice fields. UAS may also be particularly useful conducting precision agriculture functions in hilly areas or places difficult to reach using traditional aircraft.⁷ Similarly, UAS may be able to conduct work such as crop spraying closer to wind turbines and other objects often located in farm fields that may otherwise be an obstacle to safe aerial operations. Finally, UAS's remote sensing capabilities are being used to produce images that can help to detect when plants need water or fertilizer, are infested with pests and require treatment, or even when they are ready for harvest.

Delivery

⁵ Grants to date Mapped to FSDO_MASTER 120115

⁶ [Morken & Warner, 2012](#), based on data for the United States as a whole.

⁷ [Wall Street Journal, 2015](#)

Amazon's 2013 announcement that it would someday use drones as an integral part of its complex delivery system was at the leading edge of today's rapid evolution of commercial drone use. Three years later, others, such as Walmart and the Swiss Postal Service, are testing and proposing UAS-based delivery systems. In July 2015, medical supplies were flown by UAS from a Virginia regional airport over rough, rural terrain and dropped to a medical clinic. As the first such delivery approved in the US, it could be the beginning of a world where critical supplies and everyday purchases are delivered on demand by drone.⁸

Inspection

Drones are increasingly being used to inspect infrastructure, often saving time and significantly reducing the risk to humans. For example, Xcel Energy started using drones to inspect electric lines and natural gas pipelines. Inspections could be done routinely, or following severe weather in an effort to quickly assess damage or emergency repair needs. Drones will be able to cover more ground and access areas not otherwise efficiently accessible, such as the interior components of a large boiler. MnDOT is currently in the second phase of a long-term study to determine the effectiveness of utilizing drones to conduct bridge inspections. MnDOT currently inspects more than 20,000 bridges with snooper trucks or rope access.

Photography & Filmmaking

UAS are often seen as a safer, more efficient, more flexible alternative to the use of manned aircraft in many cases due to cost advantages in aerial observation and photography/cinematography.⁹ UAS use can significantly reduce the time spent collecting accurate data. For example, aerial images can be acquired from the sky, with resolutions as sharp as 1.5 cm (0.6 in) per pixel. Further, UAS technology is viewed by some in the film industry as game-changing, being able to create shots that could never be achieved before, with directors of photography starting to conceive shots around UAS.¹⁰

ISSUES & CONCERNS

While it is clear that the many current and proposed uses of UAS in today's society could have immeasurable positive impacts on the global economy as well as the health and well-being of humanity, the technology is certainly not without its drawbacks. This section considers some, but certainly not all, areas of concern drone use.

Privacy & Law Enforcement

As UAS become more prevalent, so do concerns that an operator may violate one's privacy. Use of drones for surveillance purposes raises privacy and civil liberty issues. Some drones are capable of advanced surveillance, and contain equipment such as live-feed video cameras, infrared cameras, heat sensors, and radar. Others are equipped with 'wi-fi hackers' and fake cell phone towers that can determine one's location or even intercept texts and phone calls. Even drone manufacturers have admitted that some designs will accommodate 'less lethal' weapons such as tasers or rubber bullets.

Privacy law has not kept up with the rapid pace of drone technology; one specific concern is that without an understanding of the implications, police may believe drones can be used to collect evidence on citizens without a warrant or proper legal process. In Minnesota, only a few communities have taken steps to directly regulate drone usage, though many are likely considering regulations. In February 2013, the City of St. Bonifacius approved an ordinance banning the use of aerial drones in its airspace, largely because of concerns about citizens' privacy.

So far, 26 states have enacted laws addressing UAS issues and an additional six states have adopted resolutions. Common issues addressed in the legislation include defining what a UAS, UAV, or drone is, how they can be used by law enforcement or other state agencies, how they can be used

⁸ [Popper, 2015](#)

⁹ [Planning Magazine](#), Oct 2015

¹⁰ [AUVSI report](#), Sept 2015 [Full AUVSI Report](#)

by the general public and regulations for their use in hunting game. In 2015, 45 states considered 168 bills related to drones. Twenty states passed 26 pieces of legislation, though not all were related to privacy.

Safety

The responsibility to safely fly UAS applies the same as it does for manned aircraft operations. However, the small size, shape, color, and lack of lights can make it very difficult for human pilots to visually identify UAS in-flight compared to traditional manned aircraft. Similarly, UAS are usually not currently equipped with "sense and avoid" capabilities. Sense and avoid technology may be incorporated voluntarily, or required in future UAS; for example, Amazon Inc. is touting that its proposed delivery drones' safety features would include Amazon's proposed "sense and avoid" technology.

Reports of potentially unsafe UAS operations are increasing and include unauthorized operation at and near airports, near manned aircraft and their flight paths, at major sporting events, and in restricted airspaces. An August 2015 FAA report lists 780 possible UAS encounters nationwide, with five in the Twin Cities area, compared to 238 sightings in 2014. This troubling trend points toward an increased possibility of a mid-air collision and must be taken seriously in order to prevent tragic consequences. One particularly concerning instance of UAS use interfering with manned aircraft operation occurred in summer 2015 when wild fire-fighting operations had to be suspended due to unauthorized drone use in the vicinity¹¹.

Other safety concerns include UAS crashes or mechanical failures potentially resulting in injury or property damage. UAS could also pose a homeland security risk, as terrorists could find a number of ways to utilize UAS in ways that threaten people and property.

UAS use also raises liability issues and many UAS users are considering obtaining liability insurance. There are now about a half dozen insurance companies offering policies to cover liability and damages in the event of a UAS crash or mechanical failure.¹² Similarly, Congress is considering legislation requiring drone manufactures to implement 'geo-fencing' solutions on all drones. Geo-fencing would limit, using embedded software, firmware, and GPS, where unauthorized drones can fly.

Regulation & Registration

The federal role in regulating UAS has become a moving target over the past year or so. While in some areas the FAA is moving incredibly slow to develop final rules, in other areas, such as registration, rules are moving faster than many, such as current and future hobbyist drone users, may even realize.

Congress had originally mandated that small UAS (weighing between .55 and 55lbs) rules be in place by September 30, 2015. However, the rulemaking effort is still in-process and the FAA's goal is now to finalize the rule in mid-2016. Until then, the FAA has established the previously described "exemption" system in an earnest attempt to not stifle the burgeoning UAS industry. While this process appears to be functioning adequately for the time being, it is not without confusion and lengthy waiting and processing periods.

Perhaps the most rapidly moving component of this regulatory regime is the federal registration requirement. In November 2015, a task force convened briefly and ultimately recommended that a new, streamlined UAS registration process be put in place as soon as possible. The FAA moved incredibly quickly to develop the process and on December 21, 2015, launched the new registration system. The associated rules require that any owner of a small UAS who has operated prior to December 21, 2015 to register no later than February 19, 2016. Also, owners of UAS purchased after December 21, 2015 must register before the first flight outdoors. Registrants must be at least 13 years old and provide identifying information such as name, home address and email address.

¹¹ [Nobles III, 2015](#)

¹² Planning Magazine, Oct 2015

This registration currently applies only to hobbyists but is expected to also apply to commercial users in Spring 2016. It is important to also note that the registration number non-commercial users receive under this new process is different from an N number, and is assigned to the operator to potentially be used on multiple drones. Commercial operators are still expected to have an N number for each aircraft.

In Minnesota, registration with the state is currently only required if the operator has received an N number from the FAA and intends to use the drone for commercial purposes. The minimum fee for state registration is currently \$100. Commercial registrants are also currently required to obtain a state commercial operator license. It is anticipated that state legislators will consider registration requirements and fees, among the other drone related issues previously discussed, during 2016 legislative session scheduled to begin March 2016. In an effort to help prepare legislators to consider any UAS related legislation, on December 7, 2015, MnDOT co-hosted a policy maker forum during which many of the issues described in this paper were considered.

EDUCATION

The FAA is conducting significant education and outreach efforts. The primary educational campaign being implemented is known as *Know Before You Fly*. *Know Before You Fly* is an on-line and print-based educational campaign that aims to provide prospective UAS users with the information and guidance they need to fly safely and responsibly.

Following an initial beta testing period, on January 6, 2016 the FAA released a mobile application known as B4UFLY to assist UAS operators to determine whether there are any restrictions or requirements in effect that could limit safe operation of a UAS, such as a nearby airport or other hazard.

In Minnesota, MnDOT is actively assessing UAS education needs for operators, legislators, local communities and law enforcement, among others. As the state aviation authority, MnDOT sees the importance of an education campaign to make everyone (including current pilots and the aviation community) aware and informed about responsible UAS use. MnDOT staff have availed themselves to every opportunity to educate on this topic and will continue to do so into the future. MnDOT-specific efforts include cohosting the previously noted workshop to educate legislators about UAS issues and MnDOT will also host a UAS education session for attendees of the annual Minnesota Council of Airports (MCOA) conference in the spring of 2016. Finally, MnDOT communicates to all UAS users seeking N-numbers and Section 333 Exemptions all state requirements and issues cease and desist letter when appropriate.