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FROM THE EDITOR

We are pleased to present the second issue of this journal dedicated to drone law and policy. As drones become increasingly integrated into our daily lives, the need for a robust legal framework becomes paramount. The enclosed articles highlight the role of—and the challenges presented by—drones in various sectors. These contributions underscore the transformative potential of drone technology in addressing environmental monitoring, police response, and the structure of aerial traffic management.

As editors, we remain committed to fostering a diverse and inclusive dialogue within the field of drone law and policy. We encourage submissions from scholars and practitioners of all backgrounds, as we believe that a plurality of perspectives enriches our understanding of this complex domain.

We extend our heartfelt gratitude to our contributors, reviewers, and readers for their continued support and engagement. It is through your contributions and feedback that we strive to uphold the highest standards of excellence in our journal.

We hope that you find this issue both informative and thought-provoking in addressing the legal and policy implications of drone technology.

Editor-in-Chief
Journal of Drone Law and Policy

OPERATING UNCREWED AIRCRAFT SYSTEMS (UAS) BEYOND VISUAL LACUNAE OF STATUTES – IDENTIFYING A LEGAL FRAMEWORK IN SUPPORT OF UAS TRAFFIC MANAGEMENT (UTM)

Jiajing Thach[*]

ABSTRACT

As commercial and recreational use of uncrewed aircraft systems (UAS) continues to expand, inter-agency efforts between the National Aeronautics and Space Administration (NASA) and the Federal Aviation Administration (FAA) are developing the technical and organizational architecture for their UAS Traffic Management (UTM) initiative. Eventually, the UTM ecosystem will provide for the safe and seamless integration of large-scale UAS operations into the National Airspace System (NAS). Certain milestones within UTM development have included the formation of the UTM Research Transition Team (RTT), UTM Pilot Program (UPP) and UAS Low Altitude Authorization and Notification Capability (LAANC). This article identifies the statutory and regulatory support necessary to fully implement UTM concepts. Starting with an analysis of current applications under 49 U.S.C. § 44802 (Integration of Civil Unmanned Aircraft Systems into National Airspace System) and 14 C.F.R. Parts 107 (Small Unmanned Aircraft Systems); 135 (Air Carrier and Operator Certification); and 91 (General Operating and Flight Rules) to govern UTM principles, the article will then examine recent legislation under the FAA Reauthorization Act of 2018.

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I. INTRODUCTION

In 2012, Congress mandated that the Federal Aviation Administration (FAA) must develop rules to integrate uncrewed aircraft systems (UAS) into the National Airspace System (NAS) by September 2015.[1] The use of UAS for commercial applications has expanded into multiple operational facets, including inspections, surveying, and delivery.[2] As such, the FAA and the National Aeronautics and Space Administration (NASA) are jointly creating the means to establish a UAS Traffic Management (UTM) system to fully integrate increasing UAS traffic into the NAS. In doing so, the agencies are forging public and private stakeholder partnerships while utilizing current technologies to create this new ecosystem. As stated by the Next Generation Air Transportation System (NextGen) of the FAA, these efforts will ensure that the "safety, security, efficiency, and equity of the NAS are maintained to the highest standards."[3]

Despite the promising benefits of allowing commercial operators to fly drones beyond visual line of sight (BVLOS) at low altitudes within the NAS (below 400 feet above ground level), two unique challenges exist in regards to UTM.[4] First, the uncrewed nature of UAS does not provide for the same level of situational awareness as compared to having a human onboard the aircraft to see and avoid collisions with obstacles or other aircraft.[5] This collision avoidance concern also extends to the abilities to maneuver the aircraft in a manner to avoid an accident because the human

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[1] DAVID HEFFERNAN & BRENT CONNOR, AVIATION REGULATION IN THE UNITED STATES 518 (2014). *See* FAA Modernization and Reform Act of 2012, Pub. L. No. 112-95, 126 Stat. 11 (2014). *See also* FED. AVIATION ADMIN., INTEGRATION OF CIVIL UNMANNED AIRCRAFT SYSTEMS (UAS) IN THE NATIONAL AIRSPACE SYSTEM (NAS) ROADMAP (3rd ed. 2020), https://www.faa.gov/sites/faa.gov/files/uas/resources/policy_library/2019_UAS_Civil_Integration_Roadmap_third_edition.pdf.

[2] FED. AVIATION ADMIN., UNMANNED AIRCRAFT SYSTEMS (UAS) TRAFFIC MANAGEMENT (UTM) CONCEPT OF OPERATIONS v2.0 1 (2020), https://www.faa.gov/uas/research_development/traffic_management/media/UTM_ConOps_v2.pdf [hereinafter FAA UTM CONCEPT OF OPERATIONS].

[3] *Id.*

[4] Alex Zektser & Dean Griffith, *The Regulator's Perspective: Integrating UAS into the National Airspace System*, 28 AIR & SPACE L. 3, 3 (2015).

[5] *Id.*

element has been considered to be at the heart of maintaining proper flight intervals within the NAS.[6]

The second challenge includes the potential for UAS operators to lose control of the aircraft due to a lost link between the ground control station and the drone itself.[7] The same situation may arise from a system failure onboard the aircraft, or if the aircraft is flown beyond the signal range of the communication link.[8]

In order to identify the statutory and regulatory framework that can mitigate these challenges and support a safe and seamless integration of UAS flights BVLOS into the NAS, this article will address the issue through three primary areas as they pertain to the FAA: the aircraft, the operators, and the airspace. For the aircraft, current laws regarding the required attributes of drones will be explored, to include Remote ID and other registration concerns. Then, the training and certifications for operators will be analyzed. Lastly, the nature of safely delineating the airspace for both crewed and uncrewed flights through regulatory support—along with the necessary technologies that must be available—will be discussed.

II. THE AIRCRAFT

The first consideration for UTM is the aircraft itself. To properly integrate UAS into the national airspace, the physical components that will be traversing through the air must be regulated for safe operations. In doing so, the law must be clear as to the definitions of an aircraft relative to UAS. Then, a systematic method to register and identify drones is necessary to record the ever-increasing number of aircraft, as well as to ensure they are properly equipped with components for collision avoidance. These attributes become even more pressing as the FAA expands drone operations to allow for less restrictive flights over people. Through the same rule, the agency has also granted more opportunities to conduct UAS flights at night.

As I.H.Ph. Diederiks-Verschoor stated, "UAS operations must be as safe as manned aircraft insofar as they must not present or create a greater hazard to persons, property, vehicles, or vessels

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[6] *Id.*

[7] Zektser & Griffith, *supra* note 4, at 3.

[8] *Id.*

whilst in the air or on the ground than that attributable to the operations of manned aircraft of equivalent class or category."[9]

A. Defining an Aircraft

i. The Federal Aviation Act of 1958 and *Huerta v. Pirker*

The Federal Aviation Act of 1958 defines the term "aircraft" as "any contrivance invented, used, or designed to navigate, or fly in, the air."[10] Timothy Ravich, an associate professor of legal studies at the University of Central Florida, noted that the legal definition for different types of conveyances is important, especially given that the relatively new generation of aircraft (drones) may not always be clearly categorized within the current lexicon of aircraft types.[11]

Issues surrounding how an aircraft may be defined were apparent in *Huerta v. Pirker*. In this case, the Administrator of the FAA ordered the respondent to pay a civil penalty in the amount of $10,000 based on the agency's findings.[12] The FAA alleged that the respondent violated 14 C.F.R. § 91.13(a) due to his careless or reckless operation of an uncrewed aircraft, "so as to endanger the life or property of another."[13] However, the court terminated the enforcement proceeding against the respondent, finding that the regulation did not apply because the respondent's device (a remotely-piloted Ritewing Zephyr) did not meet the definition of an aircraft under § 91.13(a).[14]

Therefore, although the legislature has provided a statutory definition for aircraft, this case demonstrates the need to clearly categorize and identify types of aircraft, particularly with drones. As the usage of UAS inevitably increases, additional manufacturers and models within this line further necessitate the need for a regulatory system to define uncrewed aircraft categories.

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[9] I.H.PH. DIEDERIKS-VERSCHOOR, AN INTRODUCTION TO AIR LAW 261 (9th ed. 2012).

[10] TIMOTHY M. RAVICH, INTRODUCTION TO AVIATION LAW 106 (2020). *See* 49 U.S.C. § 40102(a)(6).

[11] *Id.* at 107.

[12] *Id.* at 121. *See Huerta v. Pirker*, NTSB No. EA-5730 (Nat'l Transp. Safety Bd. Nov. 17, 2014).

[13] RAVICH, *supra* note 10, at 121.

[14] *Id.*

ii. 14 C.F.R. Part 107 (Small Unmanned Aircraft Systems)

14 C.F.R. Part 107 provides a foundational basis for defining drones by identifying five important components of drone operations: control station, small unmanned aircraft, small unmanned aircraft system, unmanned aircraft, and visual observer:

- *Control station* means an interface used by the remote pilot to control the flight path of the small unmanned aircraft.
- *Small unmanned aircraft* means an unmanned aircraft weighing less than 55 pounds on takeoff, including everything that is on board or otherwise attached to the aircraft.
- *Small unmanned aircraft system (small UAS)* means a small unmanned aircraft and its associated elements (including communication links and the components that control the small unmanned aircraft) that are required for the safe and efficient operation of the small unmanned aircraft in the national airspace system.
- *Unmanned aircraft* means an aircraft operated without the possibility of direct human intervention from within or on the aircraft.
- *Visual observer* means a person who is designated by the remote pilot in command to assist the remote pilot in command and the person manipulating the flight controls of the small UAS to see and avoid other air traffic or objects aloft or on the ground.[15]

In addition to the delineation between UAS and small UAS (sUAS), these terms also clarify the construct of the entire uncrewed aircraft system, which includes the ground control stations. As UAS operations are given clearance to fly BVLOS under UTM objectives, the parallel increase in the number of ground control stations presents the need to accurately define this component as well.

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[15] 14 C.F.R. § 107.3.

B. Registration and Remote ID

i. Registering UAS under 14 C.F.R. Part 107 (Small Unmanned Aircraft Systems)

Here, the regulation states that, "A person operating a civil small unmanned aircraft system for purposes of flight must comply with the provisions of § 91.203(a)(2) of this chapter."[16] In regard to the certifications required under § 91.203, an effective U.S. registration certificate issued to its owner for operations within the country must be available.[17]

In the past, the FAA faced criticism from Congress regarding its mandate to the agency to fully integrate UAS into the NAS by the September 2015 deadline.[18] The requirements and procedures involving the registration of UAS were part of the issue. In its proposed rule, published in early 2015, the FAA received over 4,000 comments filed by a litany of stakeholders, including manufacturers, airline pilots, privacy advocacy groups, retailers, railroad representatives, real estate agents, utility companies, and even movie and television producers.[19] Initially, the proposed framework from this rule would have permitted sUAS commercial operations to commence without requiring airworthiness certifications or a certificate of authorization.[20] Although sUAS would be exempt from these certifications for nonrecreational flights, the rule would nevertheless mandate operators to maintain the aircraft in a condition deemed safe for flight and to conduct preflight inspections.[21] Despite these reprieves in terms of certifications, sUAS must comply with the same aircraft registration requirements applicable to all other aircraft.[22]

Given the relatively nascent use of commercial sUAS in a BVLOS capacity, the current registration requirements are adequate to safeguard the public with regards to screening the aircraft before flights over the populace. However, as UTM becomes more

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[16] 14 C.F.R. § 107.13.
[17] 14 C.F.R. § 91.203.
[18] Brent Connor, *Perspectives on FAA's Proposed Rule on Operating Small Unmanned Aircraft Systems*, 28 AIR & SPACE L. 1, 1 (2015).
[19] *Id.*
[20] *Id.* at 20.
[21] Connor, *supra* note 18, at 20.
[22] *Id.*

prevalent, these regulations should include standardized requirements for maintenance and preflight checks. Aircraft accidents due to poor maintenance are wholly preventable, notwithstanding any product liability concerns. Such accidents are even more preventable when considering the importance of vigilant preflight inspections. The challenge comes with proper oversight and accountability for these inspections. Since it will likely not be feasible to employ an FAA program solely dedicated to the inspection of sUAS, the accountability aspect of drone accidents can be better enforced through the Remote ID program.

ii. Remote ID Under the Remote Identification of Unmanned Aircraft Systems Final Rule (14 C.F.R. Part 89)

The FAA's Office of NextGen has stated that Remote ID capabilities contribute towards public safety and security by allowing federal agencies, law enforcement, and members of the public to remotely identify UAS operating within a particular jurisdiction.[23] In its Notice of Proposed Rulemaking on Remote Identification of Unmanned Aircraft Systems, the FAA received over 53,000 comments after the notice was published in December 2019.[24] The final rule, published in the Federal Registrar in January 2021, became effective two months later.[25] According to this rule, drone operators can comply with the identification requirements of the Remote ID rule via three methods:

- Operate a standard Remote ID drone that broadcasts identification and location information about the drone and its control station. A standard Remote ID drone is one that is produced with built-in Remote ID broadcast capability in accordance with the Remote ID rule's requirements.

- Operate a drone with a Remote ID broadcast module. A broadcast module is a device that broadcasts identification and location information about the drone and its take-off location in accordance with the Remote ID rule's requirements. The

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[23] FAA, UTM CONCEPT OF OPERATIONS, *supra* note 2, at 64.

[24] *UAS Remote Identification Overview*, FED. AVIATION ADMIN. (Mar. 15, 2023), https://www.faa.gov/uas/getting_started/remote_id/ [hereinafter FAA Remote Identification Overview].

[25] *Id.*

broadcast module can be added to a drone to retrofit it with Remote ID capability. Persons operating a drone with a Remote ID broadcast module must be able to see their drone at all times during flight.

- Operate (without Remote ID equipment) at FAA-recognized identification areas (FRIAs) sponsored by community-based organizations or educational institutions. FRIAs are the only locations unmanned aircraft (drones and radio-controlled airplanes) may operate without broadcasting Remote ID message elements.[26]

The final rule also established 14 C.F.R. Part 89, which effectively mandates a "digital license plate" for uncrewed aircraft.[27]

In early April 2021, the agency also launched its online Remote ID training program, designed to provide convenience for operators certified under 14 C.F.R. Part 107 to renew their statuses without having to attend in-person testing.[28]

Remote ID is especially important as a complement to the FAA's final rule on The Operation of Unmanned Aircraft Systems Over People, which also became effective in March 2021.[29] Amending portions of 14 C.F.R. Part 107, this final rule allows for routine UAS flights over people and at night under certain circumstances.[30] Prior to conducting UAS flights at night, the aircraft must also be equipped with anti-collision lights that are visible from up to three statute miles and have a sufficient flash rate to avoid collisions.[31] Since the rule was first proposed in 2019, one change also mandated that these drones not have any exposed rotating parts that could injure others.[32] Before this final rule, UAS operations over people

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[26] *Id.*

[27] FED. AVIATION ADMIN., EXECUTIVE SUMMARY: FINAL RULE ON REMOTE IDENTIFICATION OF UNMANNED AIRCRAFT (Part 89) (2020), https://www.faa.gov/sites/faa.gov/files/2021-08/RemoteID_Executive_Summary.pdf [hereinafter FAA EXECUTIVE SUMMARY 2020].

[28] Jaron Schneider, *Drone Pilots Can Complete Remote ID Training Starting April 6*, PETAPIXEL (Apr. 2, 2021), https://petapixel.com/2021/04/02/drone-pilots-can-complete-remote-id-training-online-starting-april-6/.

[29] FAA EXECUTIVE SUMMARY 2020, *supra* note 27.

[30] *Id.*

[31] *Id.*

[32] David Shepardson, *New Rules Allowing Small Drones to Fly Over People in U.S. Take Effect*, REUTERS (Apr. 21, 2021), https://www.reuters.com/business/aerospace-defense/new-rules-allowing-small-drones-fly-over-people-us-take-effect-2021-04-21/.

were limited to flights where the people were directly involved with the flight, located under a covered infrastructure, or inside a stationary vehicle (with exceptions provided through FAA waivers).[33]

Due to the reduced visibility for flights operating at night, the Remote ID requirements will provide airspace users and any governmental authority with the ability to quickly and accurately identify drones that may have either violated restricted airspace or caused any accidents. The enhanced safety features inherent with mandating anti-collision lights will likely prove effective to promote situational awareness for anyone affected by the drone operations.

Even though 14 C.F.R. Part 89 has established the foundational basis for regulatory accountability of uncrewed aircraft operating in the NAS, additional security concerns should be addressed before allowing widespread BVLOS operations. For example, the regulation states that standard Remote ID uncrewed aircraft will transmit data from the aircraft via radio frequency broadcasts (and likely through Wi-Fi or Bluetooth technology).[34] However, the provision should include mandatory encryption or additional safeguards for an uncrewed aircraft's Remote ID. This is especially true if public Wi-Fi signals are utilized to transmit Remote ID data when the uncrewed aircraft is transporting potentially protected or sensitive information, such as medical records.

Also, 14 C.F.R. Part 89 could be further improved by associating uncrewed aircraft capabilities with § 91.225, which governs the requirements for Automatic Dependent Surveillance-Broadcast (ADS-B) Out equipment and use.[35] Currently, the intent for UTM is to initially contain UAS BVLOS operations to uncontrolled Class G airspace, where aircraft generally do not operate under the direction of air traffic controllers (ATC). However, as the logistical advantages of UAS operations become more prevalent, their flights will begin to include sectors of controlled airspace. It is foreseeable that places such as Class B airports, with a high-volume of air traffic, may eventually become popular delivery destinations for UAS carrying commercial goods. The same concerns apply to UAS BVLOS flights in metropolitan or other densely populated areas. Therefore, mandating that such uncrewed aircraft operating within

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33 *Id.*

34 FAA UAS Remote Identification Overview, *supra* note 24.

35 14 C.F.R. § 91.225.

these sectors be equipped with ADS-B Out capabilities will better serve the public in regard to promoting situational awareness for operators and ATC.

After examining the legal framework regarding uncrewed aircraft for integration into the NAS, the next area of concern is the personnel behind UAS operations.

III. THE OPERATORS

As of December 2020, the U.S. has over 203,000 FAA-certified drone operators and more than 1.7 million registered drones.[36] In addition to the regulatory requirements emplaced on the aircraft themselves, another pragmatic and effective consideration is to properly train and evaluate uncrewed aircraft operators to ensure maximum compliance under UTM principles. Regardless of the safety mitigations applied to uncrewed aircraft, such equipment can still become hazards to the aviation community without proper stewards in the form of UAS operators.

The FAA has defined "the operator" as the person or entity that is responsible for the overall management of the drone's operations.[37] Specifically, the operator "meets regulatory responsibilities, plans flights/operations, shares operation intent information, and safely conducts operations using all available information."[38]

As an additional role with a focus on flying the drone itself, the FAA has also delineated the "remote pilot in command."[39] Here, this person is solely responsible for the safe conduct of every UAS flight, and it is possible for a person to serve as both the operator and the remote pilot in command.[40] Specifically, the remote pilot in command "adheres to the operational rules of the airspace in which the [UAS] is flying; avoids other aircraft, terrain and obstacles; assesses and respects airspace constraints and flight restrictions; and avoids incompatible weather/environments."[41]

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[36] *U.S. Department of Transportation Issues Two Much-Anticipated Drone Rules to Advance Safety and Innovation in the United States*, FED. AVIATION ADMIN. (Dec. 28, 2020), https://www.faa.gov/newsroom/us-department-transportation-issues-two-much-anticipated-drone-rules-advance-safety-and.

[37] FAA UTM CONCEPT OF OPERATIONS, *supra* note 2, at 9.

[38] *Id.*

[39] *Id.*

[40] *Id.*

[41] *Id.* at 10.

A. Qualifications Under 14 C.F.R. Part 107 (Small Unmanned Aircraft Systems)

Under 14 C.F.R. Part 107, remote pilot certification requirements are listed under Subpart C.[42] Currently, the remote pilot certificate is valid for two years, and UAS operators must pass a recurrent knowledge test after those two years have elapsed.[43] As UTM progresses with its automated airspace clearance procedures, new software (most likely in the form of a mobile app) will require UAS operators to remain up to date with the inevitable flurry of new app versions. In the event that the FAA or private sector organizations cannot incrementally push these software updates in relatively seamless segments that will not materially affect UTM protocols, then UAS operators conducting BVLOS flights may need to pass these recurrent knowledge test in a more frequent manner. The challenge to mandate these shorter certificate intervals will likely entail the lagging of regulatory changes behind these software updates. To prevent this issue, the FAA may need to amend 14 C.F.R. § 107.64 (Temporary Certificate) to allow for UAS operators to temporarily update their two-year remote pilot certificates upon downloading the recent app updates and passing a corresponding online training module or exam.

As mentioned earlier, the FAA now provides an online Remote ID training program for UAS operators certified under 14 C.F.R. Part 107.[44] Although Remote ID is governed by the newly-established Part 89, certain provisions within Part 107 (such as §§ 107.65 – Aeronautical Knowledge Recency; 107.67 – Knowledge Tests: General Procedures and Passing Grades; 107.73 – Knowledge and Training; and 107.74 – Small Unmanned Aircraft System Training) should mention the Remote ID requirements for BVLOS operations under UTM. Referring to Part 89 under these sections will help to uniformly notify UAS operators of certification requirements to a wider degree. This is equally true when portions of Part 107 already refer to Part 89 regarding the decreased restrictions for drone operations over people.[45]

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[42] 14 C.F.R. 107 pt. C.

[43] *Become a Drone Pilot*, FED. AVIATION ADMIN. (Aug. 16, 2022), https://www.faa.gov/uas/commercial_operators/become_a_drone_pilot/.

[44] Schneider, *supra* note 28.

[45] 14 C.F.R. § 107.110(b), 14 C.F.R. § 107.115(b), and 14 C.F.R. § 107.140(a)(2).

B. Qualifications Under 14 C.F.R. Part 61 (Certification: Pilots, Flight Instructors, and Ground Instructors)

Next, certification regulations for pilots of crewed aircraft are stated under 14 C.F.R. Part 61.[46] The structure of Part 61 in terms of separately identifying pilots and ground instructors may need to be adopted by Part 107 as UTM progresses. As UAS BVLOS operations become more established, the distances that the drones travel will likely increase as well. Therefore, more ground control stations can be expected to support these longer flights. As the number of personnel operating these stations continue to grow, their responsibilities pertaining to the UAS flights themselves may also become more numerous. For example, a safeguard for UAS operations include lost-link capabilities, in which the aircraft will automatically abandon its previous flight route and navigate to a predetermined location if it detects a lost signal with the ground control station. Thus, Part 107 may eventually designate an additional role for extended UAS operations, such as a ground control station operator. At this point, Part 107 must also include regulations to define this role, analogous to portions of Part 61:

> § 61.1 – Applicability and Definitions.
>
> (b) For the purpose of this part:
>
> "Authorized instructor" means—
>
> (iii) A person authorized by the Administrator to provide ground training or flight training under part 61, 121, 135, or 142 of this chapter when conducting ground training or flight training in accordance with that authority.[47]

As UAS becomes fully integrated into the NAS, roles and responsibilities of operators and remote pilots will certainly change as well to include greater training requirements amidst expanded operations. In addition to the recent Remote ID requirements, the automated airspace clearance procedures within the UTM ecosystem will also necessitate more training and evaluations for UAS BVLOS flights. Then, the inevitably longer flight routes that will

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[46] 14 C.F.R. pt. 61.
[47] 14 C.F.R. § 61.1(b)(iii).

follow create a need for more ground control stations to facilitate these extended ranges. Perhaps these ground control stations may concurrently serve as logistical or distribution hubs for commercial goods to be transported via UAS operations. Regardless of how this expansion may take shape, the regulatory framework must keep pace with the progression of UTM.

After analyzing both the aircraft and the personnel components of UTM, the final factor to examine is the medium in which uncrewed aircraft will operate.

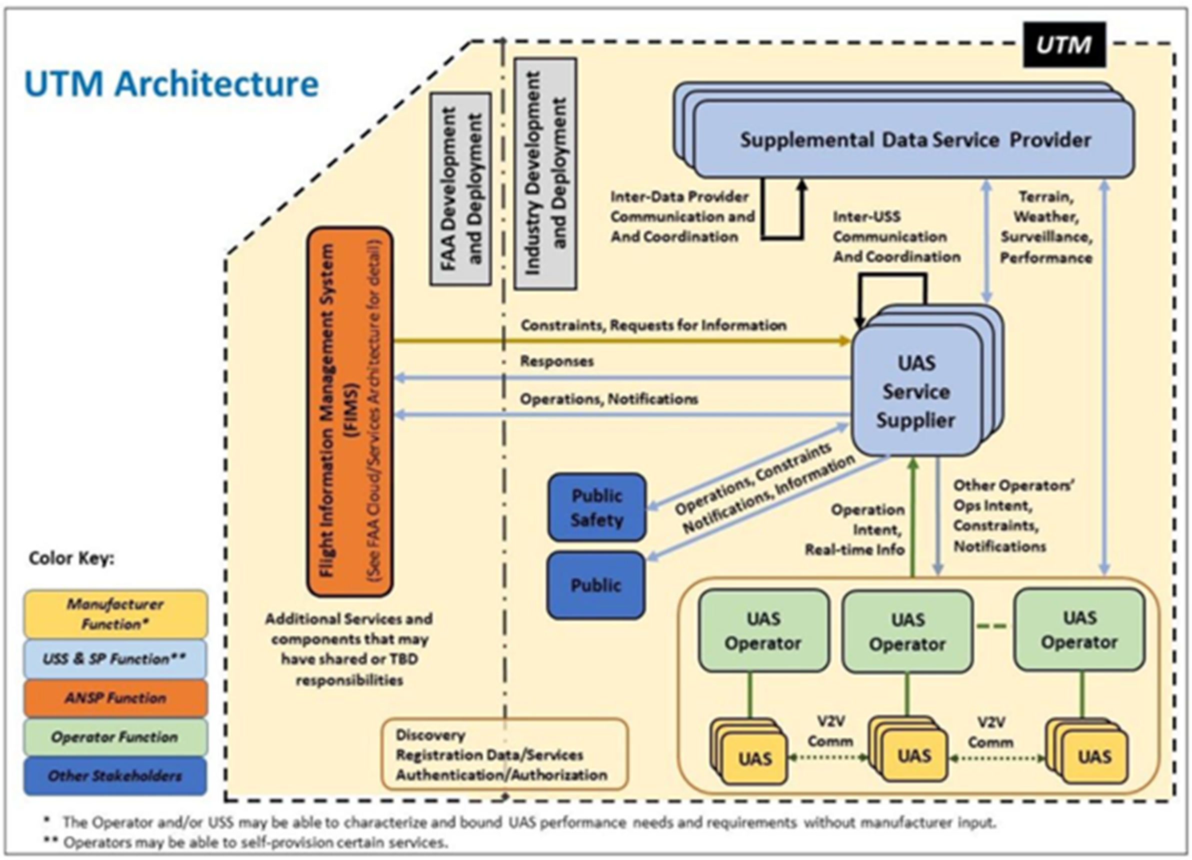
IV. THE AIRSPACE

United States (US) airspace sovereignty and its usage are established by 49 U.S.C. § 40103.[48] The generally broad provisions regarding the use of airspace are largely vested in the Administrator of the FAA:

> (b) Use of Airspace—
>
> (1) The Administrator of the Federal Aviation Administration shall develop plans and policy for the use of the navigable airspace and assign by regulation or order the use of the airspace necessary to ensure the safety of aircraft and the efficient use of airspace. The Administrator may modify or revoke an assignment when required in the public interest.
>
> (2) The Administrator shall prescribe air traffic regulations on the flight of aircraft (including regulations on safe altitudes) for—
>
> (A) navigating, protecting, and identifying aircraft;
>
> (B) protecting individuals and property on the ground;
>
> (C) using the navigable airspace efficiently; and
>
> (D) preventing collision between aircraft, between aircraft and land or water vehicles, and between aircraft and airborne objects.[49]

[48] 49 U.S.C. § 40103.
[49] 49 U.S.C. § 40103(b)(1)-(2).

In order to apply this statute to the UTM ecosystem, the FAA's Office of NextGen describes the "notional architecture" (Figure 1) by acknowledging that the agency "maintains its regulatory and operational authority for airspace and traffic operations."[50] However, the FAA makes a distinction in regards to ATC, stating that operations are instead "organized, coordinated, and managed by a federated set of actors in a distributed network of highly automated systems via application programming interfaces (APIs)."[51]



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50 FAA UTM CONCEPT OF OPERATIONS, *supra* note 2, at 8.
51 *Id.*

Figure 1. Notional UTM Architecture, Highlighting the Utilization of Third-Party Entities in Support of the FAA and UAS Operators.[52]

The FAA further defines its roles within the UTM construct, including the responsibilities to "provide a regulatory and operational framework for operations and to provide FAA-originated airspace constraint data to airspace users (e.g., airspace restrictions, facility maps, [and] active Special Activity Airspace [SAA])."[53]

Issues relating to uncrewed aircraft and airspace deconfliction measures have arisen in case law, which further supports the importance of ensuring that clearly defined and effective regulations and statutes are promulgated from the FAA and Congress, respectively. In *Singer v. City of Newton*, a dispute arose when a city ordinance mandated that all owners of uncrewed aircraft must register their drones with the city.[54] The local ordinance also prohibited the operation of uncrewed aircraft BVLOS or in designated areas without express permission.[55] As a result, the city's ordinance conflicted with the FAA Modernization and Reform Act of 2012 (FMRA), in which Congress directed the agency to, "develop a comprehensive plan to safely accelerate the integration of civil unmanned aircraft systems into the national airspace system."[56] Here, the court ruled in favor of the plaintiff on the grounds of conflict preemption, which occurs when, "compliance with both state and federal regulations is impossible or if state law obstructs the objectives of the federal regulation."[57] The court reasoned that the local ordinance was preempted by federal law because the city sought to register all uncrewed aircraft in addition to restricting their altitudinal limitations, contravening the FAA's intended authority.[58] "Newton's choice to restrict any drone use below this altitude thus works to eliminate any drone use in the confines of the city, absent prior permission. This thwarts not only the FAA's objectives, but

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[52] *Id.* at 9.

[53] *Id.*

[54] RAVICH, *supra* note 10, at 93. *See also Singer v. City of Newton*, 284 F. Supp. 3d 125 (D. Mass. 2017).

[55] RAVICH, *supra* note 10, at 93.

[56] *Id.* at 95. *See* FAA Modernization and Reform Act of 2012, *supra* note 1.

[57] RAVICH, *supra* note 10, at 95.

[58] *Id.* at 98.

also those of Congress for the FAA to integrate drones into the national airspace," the court articulated.[59]

A. 49 U.S.C. § 44802 (Integration of Civil Unmanned Aircraft Systems into National Airspace System)

This statute establishes the comprehensive plan for integrating UAS into the NAS:

> Not later than November 10, 2012, 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.[60]

In a report from the Government Accountability Office (GAO), FAA officials stated that in addition to general aviation authorities, Congress expressly authorized the agency to promulgate regulations to allow low-altitude UAS operations, "even if they occur below 'navigable airspace' pursuant to 49 U.S.C. §§ 44802 and 44807."[61] According to the GAO, these provisions codify FMRA's intent to formulate the required guidance for UAS flights "in the 'national airspace system,' provided that [the] FAA determines such operations may be carried out safely."[62] The report continues by denoting that even though Congress has not clearly defined the "national airspace system," the FAA has described the term as, "a 'network' of 'U.S. airspace' together with aviation-related facilities, rules, technical information, manpower, and material."[63] A Department of Transportation (DOT) official then distinguished the terms "national airspace system" and "navigable airspace" by stating that the former is, "a broader concept than the 'navigable airspace.'"[64]

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[59] *Id.* at 98–99.

[60] 49 U.S.C. § 44802(a)(1).

[61] U.S. GOV'T ACCOUNTABILITY OFF., UNMANNED AIRCRAFT SYSTEMS: CURRENT JURISDICTIONAL, PROPERTY, AND PRIVACY LEGAL ISSUES REGARDING THE COMMERCIAL AND RECREATIONAL USE OF DRONES 7 (2020), https://www.gao.gov/assets/b-330570.pdf.

[62] *Id.*

[63] *Id. See* FED. AVIATION ADMIN., AIR TRAFFIC CONTROL ORDER NO. JO 7110.65Y (Aug. 15, 2019), https://www.faa.gov/documentLibrary/media/Order/7110.65Y.pdf.

[64] U.S. GOV'T ACCOUNTABILITY OFF., *supra* note 61, at 7.

To clarify this concept, the FAA, in its airport airspace analysis, defined "navigable airspace" as

> the airspace at or above the minimum altitudes of flight that includes the airspace needed to ensure safety in the takeoff and landing of aircraft. Congress has charged the FAA with administering this airspace in the public interest as necessary to ensure the safety of aircraft and its efficient use.[65]

Even though this particular content from the GAO report, when coupled with the FAA's airport airspace analysis, is sufficient to delineate the differences between the terms "national airspace system" and "navigable airspace," the FAA can offer greater clarity by succinctly differentiating the spatial attributes of each term via the "General Definitions" of 14 C.F.R. § 1.1. Currently, only "navigable airspace" and "national *defense* airspace" are defined in this section, excluding "national airspace."[66]

Nevertheless, the FAA issued guidance for airspace deconfliction measures between UAS and crewed aircraft. Pursuant to FMRA, the agency issued regulations specific to UAS flight characteristics in 2015 (i.e., aircraft dimensions and low-altitude flight profile).[67] Generally, the FAA mandates that crewed aircraft will maintain an altitude of at least 500 feet above ground level (AGL), whereas sUAS will operate at no higher than 400 feet AGL to offer vertical separation between the two aircraft types.[68]

B. 14 C.F.R. Part 91 (General Operating and Flight Rules)

Currently, § 91.225 of this regulation generally prohibits remote pilots from operating UAS with ADS-B Out equipment in transmit mode unless:

- The operation is conducted under a flight plan and the person operating that unmanned aircraft maintains two-way communication with ATC; or

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[65] *Airport Airspace Analysis (AAA)*, FED. AVIATION ADMIN. (Oct. 5, 2022), https://www.faa.gov/airports/engineering/airspace_analysis/.
[66] 14 C.F.R. § 1.1.
[67] U.S. GOV'T ACCOUNTABILITY OFF., *supra* note 61, at 7.
[68] *Id.*

- The use of ADS-B Out is otherwise authorized by the Administrator.[69]

Referring to the previous section discussing collision-avoidance capabilities for UAS, the FAA can consider lifting the blanket restriction in preparation for increased UAS traffic in vicinity of Class B airports or over densely populated urban areas once UTM becomes more prevalent. The two-way communication mandate could needlessly overburden remote pilots in command and would require additional training to ensure proficiency at the cost of efficiency. The automated nature of UTM to facilitate increased UAS traffic would be degraded with these increased demands on the personnel conducting UAS operations. The general exception allowing the FAA Administrator to grant ADS-B Out usage to UAS further supports the notion that these limitations are unnecessarily restrictive.

C. FAA Reauthorization Act of 2018

Another legislative action to consider is the FAA Reauthorization Act of 2018. In addition to highlighting the Remote ID program, as well as public safety concerns due to widespread UAS operations, this Act also addresses the carriage of property by small uncrewed aircraft systems.[70] Recognizing the cargo delivery capabilities of UAS, former FAA Deputy Administrator Daniel Elwell stated that regulations must be promulgated to authorize "the carriage of property by operators of UAS for compensation or hire in the United States."[71] These efforts to promote UAS operations for package deliveries included the recent final rules allowing for more flights over people and at night.[72] Elwell also shared that the FAA had issued the first ever air carrier certification for a commercial UAS operation, allowing for package deliveries through drone flights to rural Blacksburg, Virginia.[73]

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[69] 14 C.F.R. § 91.225(i)(2).

[70] *Implementation of the FAA Reauthorization Act of 2018*, Dep't of Transp. (Sept. 26, 2019), https://www.transportation.gov/testimony/implementation-faa-reauthorization-act-2018.

[71] *Id.*

[72] *Id.*

[73] *Id. See also Drone Delivery Launches in Southwest Virginia*, VA. TECH (Oct. 18, 2019), https://vtnews.vt.edu/articles/2019/10/ictas-wingdronedeliverylaunch.html

D. Research Transition Team (RTT)

In addition to the statutes and regulations mentioned, an RTT has been established amongst the FAA, NASA, and industry stakeholders to promote the UTM initiative.[74] The group acknowledges the inherent challenges with integrating UAS operations at low altitudes in both controlled and uncontrolled airspace.[75] As a solution to integrate private stakeholders into UTM, the RTT has developed Joint Management Plans (JMPs) to memorialize specific actions, create corresponding timetables for accomplishments, assign organizational roles and responsibilities, and describe the desired metrics for any planned outcomes from the collaborative effort.[76]

As the aforementioned roles and responsibilities from private stakeholders take shape, corresponding updates to 14 C.F.R. Part 107, and possibly Part 89, should follow. Setting the regulatory guidance for this dynamic initiative is important because local, private stakeholders may vary drastically amongst different airspace sectors throughout the US. Therefore, a defined set of rules to manage this civil-governmental relationship will be paramount for the success of UTM.

E. Low Altitude Authorization and Notification Capability (LAANC)

In support of the collaborative approach between the public and private sectors to share airspace information, the FAA has also created its UAS Data Exchange.[77] Under the agency's UAS Data Exchange umbrella, multiple partnerships will benefit through the LAANC.[78] The FAA states that, "LAANC automates the application

(introducing Wing, a drone-delivery company associated with Google's parent company Alphabet).

[74] *Unmanned Aircraft System Traffic Management (UTM)*, FED. AVIATION ADMIN. (Aug. 16, 2022), https://www.faa.gov/uas/research_development/traffic_management/.

[75] FED. AVIATION ADMIN. & NAT'L AERONAUTICS AND SPACE ADMIN., UAS TRAFFIC MANAGEMENT (UTM) RESEARCH TRANSITION TEAM (RTT) PLAN: FAA AND NASA COLLABORATIVE EFFORTS PLANNED THROUGH SEPTEMBER 2020 6 (2017), https://www.faa.gov/sites/faa.gov/files/2022-08/FAA_NASA_UAS_Traffic_Management_Research_Plan.pdf.

[76] *Id.* at 5.

[77] RAVICH, *supra* note 10, at 81.

[78] *Id.*

and approval process for airspace authorizations."[79] In doing so, it provides UAS operators with access to controlled airspace below 400 feet AGL, allows for greater awareness for restricted airspace, and enhances situational awareness for air traffic personnel regarding their ability to identify and track drone flights.[80] The system also checks airspace approval requests against multiple data sources, including "UAS Facility Maps, Special Use Airspace Data, Airports and Airspace Classes, as well as Temporary Flight Restrictions (TFRs) and Notices to Airmen (NOTAMs)."[81] Once these requests are approved, UAS operators can receive nearly instant authorization through the automated process.[82]

LAANC represents an ambitious and fruitful collaborative effort between the FAA and private entities within the aviation industry. At this time, the agency has approved 16 UAS Service Suppliers (USS) to provide LAANC services in accordance with both 14 C.F.R. Part 107 and 49 U.S.C. § 44809 (Exception for Limited Recreational Operations of Unmanned Aircraft.)[83] Additionally, since the LAANC program launched in 2017, the FAA has expanded the initiative nationwide, encompassing more than 500 airports.[84]

V. THE FUTURE

A. UTM Pilot Program (UPP)

The FAA Extension, Safety and Security Act of 2016 established the UPP to identify required capabilities from both the FAA and the aviation industry in support of the UTM initiative.[85] UPP currently consists of two phases:

Phase 1

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[79] *Id.*

[80] *UAS Data Exchange (LAANC),* FED. AVIATION ADMIN. (Nov. 18, 2021), https://www.faa.gov/uas/programs_partnerships/data_exchange/.

[81] *Id.*

[82] *Id.*

[83] *Id.*

[84] William Goodwin & Tyler Finn, *The Local Future of the Low-Altitude Airspace*, 31 AIR & SPACE L. 1, 20 (2018).

[85] *UTM Pilot Program (UPP).* FED. AVIATION ADMIN. (May 27, 2022), https://www.faa.gov/uas/research_development/traffic_management/utm_pilot_program/.

- Selected UAS test sites:

  o Nevada Institute for Autonomous Systems (NIAS)

  o Northern Plains UAS Test Site (NPUASTS)

  o Virginia Tech, Mid Atlantic Aviation Partnership (MAAP)

- Demonstrated UTM services:

  o Exchange of flight intent among operators;

  o Generation of notifications to UAS operators regarding air and ground activities, known as UAS Volume Reservations (UVRs); and

  o Sharing of UVRs with stakeholders, including other USS and the Flight Information Management System (FIMS).

Phase 2

- Selected UAS test sites:

  o Griffiss International Airport (NYUASTS)

  o Virginia Tech, Mid Atlantic Aviation Partnership (MAAP)

- The FAA Reauthorization Act of 2018 directed the agency to meet additional testing objectives, including Remote [ID] technologies and operations amidst higher air traffic volumes.[86]

Upon the completion of Phase 2, the FAA will share test results with stakeholders to continue enabling technologies for the UTM ecosystem, such as Remote ID services, which will eventually enable increasing BVLOS operations.[87] This structured approach to continue developing the necessary technological capabilities to promote UTM is important as the FAA has conducted real-world testing at sites to relay pertinent data to the private sector. Therefore, this process further bolsters the FAA's collaboration with USS to

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[86] *Id.*
[87] *Id.*

ensure airspace deconfliction abilities will allow for the full integration of UAS into the NAS.

B. Pilotless, Passenger-Carrying Drones

Finally, as commercial UAS operations perfect automated package delivery capabilities within the US, a possible new horizon will include pilotless drones to transport passengers.[88] Using "sense-and-avoid" equipment, full automation, and the full array of capabilities provided by the UTM ecosystem, these pilotless vehicles will likely start as short-distance, vertical takeoff and landing (VTOL) aircraft.[89]

However, certain issues may arise with this new form of transportation. These include fair practices in allowing private entities equal access to the UTM Registry across every airspace sector.[90] Additionally, the process for awarding these potential government contracts for UTM services may implicate antitrust violations.[91] Since 14 C.F.R. Part 107 currently does not mandate airworthiness certificates for uncrewed aircraft, these safety concerns must also be addressed before the capabilities become a reality.[92]

Despite these foreseeable obstacles hindering pilotless, passenger-carrying drones, the continuing efforts behind UTM are incrementally providing the technological basis for this possibility. Once public and private aviation sectors fully solidify their collaborative ventures to integrate UAS BVLOS operations across all airspace regions within the US, then innovation will undoubtedly drive this future mode of transportation.

VI. CONCLUSION

As former FAA Acting Chief Counsel and Deputy Chief Counsel Marc Warren stated, "Law and policy should enable, not hinder, UAS integration."[93] Upon analyzing the current legal framework governing uncrewed aircraft, their operators, and the airspace in

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[88] E. Tazewell Ellett & Matthew J. Clark, *Passengers Without Pilots*, 45 VBA J. 18, 19 (2018).

[89] *Id.* at 20.

[90] *Id.* at 21.

[91] *Id.*

[92] *Id.* at 22.

[93] Marc Warren, *UAS Integration: A Call to Action*, 27 AIR & SPACE L. 1, 20 (2014).

which they fly, it is apparent that governmental efforts have established a solid, yet dynamic collection of air law statutes and regulations to propel UAS integration into the NAS via UTM. The ever-important need to constantly anticipate, assess, and act in regards to legal considerations supporting the aviation industry remains vital for future UTM accomplishments.

THE USE OF REMOTE SENSING IN REAL PROPERTY TRANSACTIONS AND CONSTRUCTION

Clint S. Dunaway, Esq.[*]

ABSTRACT

Remote sensing has the potential to be hugely beneficial to real property transactions and construction. The information it collects through imagery and other instruments can show what areas of land are susceptible to dangerous conditions. If this information is gathered and provided to developers or would-be property owners, this could prevent the destruction of homes and other structures in areas would otherwise have been thought to be safe. Gathering information via remote sensing should be a requirement prior to development for this reason.

I. INTRODUCTION TO REMOTE SENSING

Remote sensing, in the simplest words, means obtaining information about an object without being in touch with it – thus in contrast to on-site observation.[1] Remote sensing consists of collecting

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[1] The United States House of Representatives Committee on Science and Astronautics additionally defined remote sensing as "the acquisition of information about specific objects or phenomena in which the information gathering device is not in intimate contact with the subject under investigation." GEORGE J. ZISSIS, *The Development of Remote-Sensing of Earth Resources, in* REMOTE SENSING OF EARTH RESOURCES 119, 120 (1972). *See also* the UNITED NATIONS COMMITTEE ON PERMANENT USES IN OUTER SPACE, DRAFT REPORT OF THE WORKING GROUP ON REMOTE SENSING OF THE EARTH BY SATELLITES ON THE WORK OF ITS SECOND SESSION, U.N. COPUOS, U.N. Doc. A/AC. 105/C.1/WG.4/L.4 at 2 (1973), stating that:

data from objects, materials, and situations on the Earth by means of sensors mounted onto crafts at sea, in the air, and in space, and then processing the data for quantification, qualification, and mapping purposes.[2] Remote sensing can be used to look at soil composition and determine a location's susceptibility to natural disasters.

Remote sensing is used in numerous fields, including geography, land surveying, and most Earth science disciplines such as hydrology, oceanography, glaciology, and geology. It also raises many interesting and complex questions regarding privacy and the rights to captured information, such as whether a person may be compensated for information remotely taken from his or her property without permission or knowledge. All of these are fascinating topics; however, for the purposes of this article, I will focus on the use of remote sensing real property in real estate transactions and development..

A. The Origins and Evolution of Remote Sensing

In its most basic form, remote sensing of the land is not something new. Prior to civilian use, satellites were used by the military and intelligence forces of the major world powers.[3] The technology quickly moved into non-military applications.

The first remote measurements of the earth by satellite for civilian purposes were made by the meteorological satellite, Television Infrared Observation Satellite (TIROS-1), which was launched by NASA on April 1, 1960.[4] Then, in 1972, when the United States

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> [R]emote-sensing of the earth from outer space is defined as a methodology to assist in characterizing the nature and/or condition of features or phenomena on, above or below the earth's surface by means of observation and measurements from space platform … at present, such methods depend upon the emission and reflection of electromagnetic radiations.

[2] Patrick A. Salin, *Proprietary Aspects of Commercial Remote-Sensing Imagery*, 13 NW. J. INT'L L. & BUS. 349, 352 (1992) (citing Sikke A. Hempenius, Inaugural speech at the Agricultural University of Wageningen, Netherlands (March 1978)).

[3] Michael R. Hoversten, *U.S. National Security and Government Regulation of Commercial Remote Sensing from Outer Space*, 50 A.F. L. REV. 253, 253 (2001).

[4] *TIROS*, NAT'L AERONAUTICS AND SPACE ADMIN. (May 22, 2016), https://science.nasa.gov/missions/tiros.

launched its Earth Resources Technology Satellite (ERTS-1)[5] (later renamed LANDSAT 1), remotely sensed imagery became commercialized.[6] After the launch of ERTS-1, other countries began launching their own satellites and the availability of remotely sensed imagery became more widely accessible.[7]

Later, NASA would sell data from LANDSAT to other States through bilateral contracts.[8] These contracts enabled these countries to establish ground stations in their own territory.[9] The data from LANDSAT was then transmitted to receiving stations on the ground.[10] In exchange for access to LANDSAT data, station operators of participating countries paid a large annual access fee and a distribution fee on each data product sold.[11]

In 1992, the United States Congress passed Section 5621 of the Land Remote-Sensing Policy Act, which authorized the Secretary of Commerce to issue licenses for private space-based remote-sensing systems.[12] The Act defines land remote sensing as the collection of data which can be processed into imagery of surface features on the Earth from a satellite.[13] Private companies then began selling the high-resolution images of the Earth and its resources.[14]

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[5] Hoversten, *supra* note 3. *See also* JOHN H. BOEKEL, NAT'L AERONAUTICS AND SPACE ADMIN., ERTS-1 SYSTEM PERFORMANCE OVERVIEW 2 (1974), https://ntrs.nasa.gov/api/citations/19740022593/downloads/19740022593.pdf.

[6] Hoversten, *supra* note 3, at 254.

[7] *Id.* at 253-254.

[8] Patrick A. Salin, LANDSAT Contracts Signed by US Agencies with Foreign Ground-Stations: Commercial Remote-Sensing from NASA Scientific Experiments to EOSAT Private Endeavours, 41 ZLW 165, 165-167 (1992) [hereinafter LANDSAT Contracts]. See also Fifteen Years of Open Data Allows Advancements in Landsat Use and Research, NAT'L AERONAUTICS AND SPACE ADMIN. (Apr. 21, 2023), https://landsat.gsfc.nasa.gov/article/fifteen-years-of-open-data-allows-advancements-in-landsat-use-and-research/.

[9] Salin, *LANDSAT Contracts*, *supra* note 8, at 167.

[10] *Id.*

[11] *Id. See generally* International Cooperation and Competition in Space, Hearing Before the Subcommittee on Space Science and Applications of the Committee on Science and Technology, 98th Cong., 2d Sess. 126 (1984).

[12] 15 U.S.C. § 5621 (1992).

[13] 15 U.S.C. § 5602 (1992).

[14] Hoversten, *supra* note 3, at 254.

In March 1994, the Clinton administration passed a policy allowing the private sale of images obtained from remote-sensing systems.[15]

The result of this policy was that American companies were free to exchange and sell remotely sensed images in the international market, regardless of whether that information had been obtained from satellite, crewed aircraft, or uncrewed aircraft.[16] In the current day, remotely-sensed imagery can easily be available to developers, insurance companies, and others with an interest in real estate.

B. Components of a Remote-Sensing System

The primary components of a remote-sensing payload system include a laser, scanner, high resolution digital still camera(s), and video camera(s).[17] These components work together to produce photogrammetric images, which are obtained through photogrammetry, the process of capturing the physical dimension of objects on or above the surface of the Earth from measurements on aerial photographs of the objects. Images of an object or a scene of objects are taken from different angles, allowing data such as measurements, distances, and surface properties to be extracted.[18] The end product is a 3D model of the objects measured.

These photogrammetric images provide the qualitative and quantitative characteristics of the objects recorded.[19] Qualitative characteristics are those such as shape, pattern, tone, and texture (for example, identifying deciduous versus coniferous trees, delineation of geologic landforms, and inventories of existing land), while quantitative measurements can include rock height, tree height,

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[15] White House, Presidential Decision Directive/NSC-23: U.S. Policy on Foreign Access to Remote Sensing Space Capabilities 6 (1994), https://clinton.presidentiallibraries.us/items/show/12747.

[16] *Id.* at 2. "The fundamental goal of the policy is to support and to enhance US industrial competitiveness in the field of remote-sensing…[w]hile at the same time protecting US national security and foreign policy interests."

[17] *See generally* Mojtaba Abolghasemi & Dariush Abbasi-Moghadam, Design and Performance Evaluation of the Imaging Payload for a Remote Sensing Satellite, 44 OPTICS & LASER TECH. 2418, 2418 (2012).

[18] UNIV. OF ARIZONA, PRINCIPLES OF PHOTOGRAMMETRY (1993), 1 https://lpl.arizona.edu/hamilton/sites/lpl.arizona.edu.hamilton/files/courses/ptys551/Principles_of_Photogrammetry.pdf.

[19] *Id.*

stockpile volumes, and the coordinates of unknown points.[20] The quantitative characteristics of objects such as size, orientation, and position are determined from measured image positions in the image plane of the camera taking the photograph.[21]

Sensing techniques may be passive or active.[22] In a passive system, the remote sensing instrument simply receives whatever radiation happens to arrive and selects the radiation of the particular wavelength range that it requires.[23] In an active system, the remote sensing instrument itself generates radiation, transmits that radiation toward a target, receives the reflected radiation from the target, and extracts information from the return signal.[24]

"LIDAR," which stands for Light Detection and Ranging, is an active remote sensing method that uses light in the form of a pulsed laser to measure distances between objects.[25] A LIDAR instrument principally consists of a laser, a scanner, and a specialized GPS receiver.[26] These light pulses – combined with other data recorded by the airborne system – generate precise, three-dimensional information about the shape of the Earth and its surface characteristics.[27] LIDAR systems are used to examine both natural and manmade environments with accuracy, precision, and flexibility.

Additionally, there are two subcategories of LIDAR, topographic and bathymetric, each of which performs different functions. Topographic LIDAR uses a near-infrared laser to map the land and objects on the land, while bathymetric LIDAR uses a water-penetrating green light to measure the "beds" or "floors" of water bodies, including the ocean, rivers, streams, and lakes.[28]

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20 *Id.*

21 *Id.*

22 *Passive vs Active Sensors in Remote Sensing*, GIS GEOGRAPHY, https://gisgeography.com/passive-active-sensors-remote-sensing/#:~:text=Types%20of%20Remote%20Sensing&text=Active%20sensors%20have%20their%20own,passive%20sensors%20measure%20this%20energy (last visited May 30, 2022).

23 *Id.*

24 *Id.*

25 *What Is Lidar?*, NAT'L OCEANIC AND ATMOSPHERIC ADMIN., https://oceanservice.noaa.gov/facts/lidar.html (last visited Jan. 20, 2023).

26 *Id.*

27 *Id.*

28 *Id. See also* NAT'L OCEANIC AND ATMOSPHERIC ADMIN., LIDAR 101: AN INTRODUCTION TO LIDAR TECHNOLOGY, DATA, AND APPLICATIONS 35 (2012), https://coast.noaa.gov/data/digitalcoast/pdf/lidar-101.pdf [hereinafter NOAA, LIDAR 101].

There are several combined topographic and bathymetric LIDAR systems that have been used extensively to map shoreline and nearshore areas. Combined topographic-bathymetric LIDAR data sets, such as those collected by the Joint Airborne LIDAR Bathymetry Technical Center of Expertise (JALBTCX),[29] provide the elevation data required to produce datum-based shorelines.[30] The gathered data can be used to show how high-water levels may rise, giving developers a better idea of the risks of building in a particular area.

Platforms used in remote sensing include satellites, manned aircraft, and unmanned aircraft systems (UAS).[31] Airplanes and helicopters are the most commonly used platforms for acquiring LIDAR data over broad areas.[32] As laser scanners have become smaller, smaller aircraft are able to carry them.

C. Remote Sensing Using Unmanned Aircraft Systems (UAS)

While there are many benefits to using manned aircraft, the biggest downside, whether fixed wing or helicopter, is the cost,

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[29] *Joint Airborne Lidar Bathymetry Technical Center of Expertise*, US ARMY CORPS OF ENGINEERS, https://www.sam.usace.army.mil/Missions/Spatial-Data-Branch/JALBTCX/ (last visited July 9, 2023).

> The mission of the Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX) is to perform operations, research, and development in airborne lidar bathymetry and complementary technologies to support the coastal mapping and charting requirements of the U.S. Army Corps of Engineers, the U.S. Naval Meteorology and Oceanography Command, and the National Oceanic and Atmospheric Administration (NOAA). JALBTCX staff includes engineers, scientists, hydrographers, and technicians from the Army Corps of Engineers Mobile District, the Naval Oceanographic Office (NAVOCEANO), the Corps Engineer Research and Development Center (ERDC), and the NOAA National Geodetic Survey (GDS). *Id.*

[30] NOAA, LIDAR 101, *supra* note 28, at 58.

[31] Unmanned aircraft: a device used or intended to be used for flight in the air that has no onboard pilot. This definition includes all classes of airplanes, helicopters, airships, and powered lift aircraft without an onboard pilot. *See* FED. AVIATION ADMIN., INTEGRATION OF CIVIL UNMANNED AIRCRAFT SYSTEMS (UAS) IN THE NATIONAL AIRSPACE SYSTEM (NAS) ROADMAP (2020), https://www.faa.gov/sites/faa.gov/files/uas/resources/policy_library/2019_UAS_Civil_Integration_Roadmap_third_edition.pdf [hereinafter FAA UAS INTEGRATION ROADMAP].

[32] *What Is Lidar?*, *supra* note 25.

especially when compared to UAS.[33] The benefits of remote sensing via UAS include low material and operational costs, flexibility with the control of spatial and temporal resolution, high intensity data collection, and absence of risk to crew members.[34]

Flexible and inexpensive remote-sensing systems can help supplement existing remote-sensing capabilities and explore new applications. UAS as remote-sensing platforms increase the efficiency of data acquisition, and fill gaps and supplement the capabilities of manned aircraft and satellites. UAS are an increasingly popular platform for remote sensing. Their ability to fly at low altitudes helps in the acquisition of high-resolution images and information. Unmanned aircraft[35] are becoming large enough that they can carry heavier payloads and fly further.[36] Increasingly smaller, lighter, and cheaper sensors have become available for drone remote-sensing applications.

Traditionally, remote sensing could only be done with satellites or manned aircraft.[37] However, unmanned aircraft are now able to fly these missions at a much lower cost. Advances in technology are one reason for the decrease in price. UAS are cost effective when compared to manned aircraft because they do not have to carry the weight of a human, and they are much smaller than a traditional helicopter or fixed wing aircraft.[38]

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[33] *See Are UAS More Cost Effective Than Manned Flights?*, ASS'N FOR UNCREWED VEHICLE SYS. INT'L (Oct. 24, 2013), https://www.auvsi.org/are-uas-more-cost-effective-manned-flights.

[34] Aleksander Olejnik, Łukasz Kiszkowiak, Robert Rogólski, Grzegorz Chmaj, Michał Radomski, Maciej Majcher, & Łukasz Omen, *The Use of Unmanned Aerial Vehicles in Remote Sensing Systems*, 20 SENSORS (SPECIAL ISSUE: SELECTED PAPERS FROM THE 2019 IEEE INTERNATIONAL WORKSHOP ON METROLOGY FOR AEROSPACE) 1, 1 (2020).

[35] The FAA does not use the terms "unmanned aircraft system" and "unmanned aircraft" interchangeably. It uses the term "unmanned aircraft" when referring specifically to the unmanned aircraft itself and "unmanned aircraft system" when referring to both the unmanned aircraft and any communication links and components that control the unmanned aircraft. *See* 14 C.F.R. 1.1.

[36] Unmanned aircraft operations have significantly increased in number, technological complexity, and sophistication during recent years without specific regulations to address the unique characteristics, though existing rules have not been fully tailored to the unique features of unmanned aircraft. *See* FAA UAS INTEGRATION ROADMAP, *supra* note 31.

[37] *History of Remote Sensing*, HUMBOLDT STATE UNIV., http://gsp.humboldt.edu/olm/Courses/GSP_216/online/lesson1/history.html (last visited July 9, 2023).

[38] The Bell 429 helicopter is a widely used helicopter with an hourly cost of approximately $1,860. *See BELL 429 Price and Operating Costs*, AIRCRAFT COST CALCULATOR,

UAS can carry a variety of sensing instruments, including visible light, near infrared, shortwave infrared, thermal infrared, radar, and LIDAR sensors.[39] UAS are able to perform unique remote sensing functions. Consider forest canopy height, which is a critical parameter of forest health, and which was traditionally estimated with analog photos and ground surveys. However, though LIDAR technologies have become a new means for estimating canopy height, and traditional photogrammetry has almost been abandoned in forestry,[40] small forest gaps, which reflect disturbance and affect forest diversity and productivity, cannot be measured accurately with satellite remote sensing.[41] Additionally, LIDAR imaging can be used to gather accurate information about forest composition, structures, volume, and growth.[42] This suggests that drone remote sensing is capable of acquiring very high-resolution images suitable for characterizing forest gaps as reliable indicators of biodiversity.[43] LIDAR imaging can get measurements of tree sizes and forest density, and it can track the changes to soil that are natural or human-made.[44] Vegetation can have a substantial impact on the movement of soil, and so the ability to track vegetation helps predict future changes in the soil.[45] This can help to better understand the long-term and short-term risks of building in a specific area.

II. BENEFITS OF REMOTE SENSING

One of the major advantages of aerial remote sensing techniques is the creation of a permanent archive of baseline data. Then, as new information is gathered, it can be compared to the historic information, allowing future trends to be hypothesized. For instance, the current makeup of a hillside or riverbed could be

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https://www.aircraftcostcalculator.com/AircraftOperatingCosts/396/Bell+429 (last visited July 9, 2023). *See also* ASS'N FOR UNCREWED VEHICLE SYS. INT'L, *supra* note 33.

39 P. Krishna Rao, Susan J. Holmes, Ralph K. Anderson, Jay S. Winston, & Paul E. Lehr, *Remote Sensing Instrumentation*, *in* Weather Satellites: Sys., Data, and Env't Applications 105-106 (1990).

40 Lina Tang & Guofan Shao, *Drone Remote Sensing for Forestry Research and Practices*, 26 J. FORESTRY RSCH. 791, 792 (2015).

41 *Id.* at 793.

42 *Id.* at 791.

43 *Id.*

44 *Id*.

45 *See* P. Zhou, O. Luukkanen, T. Tokola, & J. Nieminen, *Effect of Vegetation Cover on Soil Erosion in a Mountainous Watershed*, 75 CATENA 319 (2008).

compared to previous data and the differences can be measured. By knowing how much soil has moved in a particular period, one may hypothesize how much soil will move in the future. This will help developers determine if it is safe to build in a particular location.

Remote sensing real property will have a positive impact on a majority of Americans. It can benefit anyone who ever buys or sells a home. Additionally, it impacts people who are not homeowners because natural disasters do not spare rentals – every person interacts with real estate in some way. Remote sensing can be used as part of the construction process. The information obtained through these observations can help engineers, architects, insurers, and government entities make educated decisions about where to allow construction or where a developer would want to develop.

Information obtained through remote sensing could make everyone involved in the real estate transaction or construction more informed and protected. It could be used by insurers as part of the underwriting process. Municipalities could require it as part of the permitting process. Banks could require it as part of the loan application process.

Considerations include rebuilding in an area that has already suffered damage from fire, flood, or earthquake. If consumers knew remote sensing was an option, they would likely happily pay money to know the likelihood of a potential disaster. For example, someone moving from the Midwest to a mountainous part of the country might not understand the risks associated with purchasing a home on a cliff or mountainside. Similarly, someone moving from a mountainous part of the country to the Gulf Coast might not understand the risks from flooding.

Information about the shorelines and changes in riverbed elevations can help predict the future movement of water.[46] It can also predict where the water levels will be during a flooding event.[47] Developers can then determine how safe it is to build a home in a specific area or the likelihood of a home suffering damage in a flood.

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[46] Hafiz Suliman Munawar, Ahmed W.A. Hammad, & S. Travis Waller, *Remote Sensing Methods for Flood Prediction: A Review*, 22 SENSORS (SPECIAL ISSUE: REMOTE SENSING FOR INTEGRATED DISASTER RISK MANAGEMENT) 960, 968 (2022).

[47] *Id.*

Valuable and detailed information can be gathered when remotely sensing soil.[48] The type of rock formation and makeup can be determined by the energy absorbed.[49] Different metals react differently, and so it can be determined what type of rock make up a particular soil.[50] The soil makeup will determine the absorption levels of water from snow, rain, and floods.[51] This information will indicate the soil's vulnerability to erosion, mudslides, earthquakes, sink holes, and other potentially catastrophic events.

Information can be used prior to the development of homes or commercial buildings. The information can be used when accessing the risk of *rebuilding* in a "high risk" area that has already been hit by a natural disaster. For example, in Montecito, California, homeowners are rebuilding their mansions after they were completely destroyed in a 2018 mudslide.[52] All parties involved in the rebuilding – homeowners, property insurers, bankers, and municipalities – should have the information available to know where the land was, where it is now, and where it will likely be in the coming years. That specific mudslide was caused after strong rains hit an area that had recently burned from a forest fire. Remote sensing can determine, with pin-point accuracy, the current state of the vegetation, where it is coming back, and where it is still very barren.

A. Municipalities Would Benefit from Remotely Sensing Property

When disaster strikes, municipalities must spring into action. Government entities would be wise to require remote sensing as part of the building/zoning/application process – especially for large projects. In an effort to make residents safe, municipalities get involved in the tiniest of details when it comes to the development of

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[48] *See* Mehrez Zribi, Nicolas Baghdadi, & Michel Nolin, *Remote Sensing of Soil*, 2011 APPLIED & ENV'T SOIL SCI. (SPECIAL ISSUE) 1 (2011).

[49] A. Nathues, MAX PLANCK GESELLSCHAFT, METHODS FOR REMOTE SENSING OF SURFACE COMPOSITION 12 (2023), https://www.mps.mpg.de/phd/planetary-interiors-and-surfaces-2011-part-02.pdf.

[50] *Id.* at 16.

[51] *See generally* Darrell Norton, Issac Shainberg, Larry Cihacek, & J.H. Edwards, *Erosion and Soil Chemical Properties*, in SOIL QUALITY & SOIL EROSION 39 (1999).

[52] *Montecito Digs Out from Deadly Mudslides* (CBS Los Angeles television broadcast Jan. 9, 2018), https://youtu.be/5wsZi_-puH8?t=44.

real property. They get involved to save lives. Building codes have saved countless lives.

In Buckeye, Arizona, a master planned community that will have a total buildout of more than 100,000 homes and 55 million square feet of commercial buildings is currently under construction.[53] Before a development such as this is approved, the land should be remotely sensed to look for any unknown flood zones, sink holes, or fault lines. Building permits should not be given until the developer can show that there are no unknown dangers beneath the land.

B. *Benefit to Insurance Companies and Lending Institutions*

Insurance companies are the one group who could benefit more from remote sensing than any other on this list.[54] Their whole business is determining the risk that an area of real property will be damaged and if so, how much it will cost to repair it. Insurers should be excited at the opportunity to avoid problems before it is too late, particularly at such accuracy and cost-effectiveness.

Insurance companies are in the business of analyzing risk, quantifying the value of that risk, and then providing benefit to their clients. Insurers could benefit by requiring would-be clients to obtain coverage/policy or they could provide a discount for those who had sensed their property and could show that it was free from material defects.

Additionally, lending institutions would benefit from an enhanced understanding of the land where a home is or will be located. If a debtor or client's home is destroyed by a natural disaster, it is likely that they will not be making their monthly mortgage payments while things are being sorted out. Often, after a disaster, insurance companies are slow to settle with homeowners about what is and is not covered under their policy.

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[53] *100,000-Home Teravalis Breaks Ground in Buckeye*, AZBIGMEDIA (Dec. 18, 2022), https://azbigmedia.com/real-estate/massive-teravalis-master-planned-community-breaks-ground-in-buckeye.

[54] Steph Bednar, *Underwriting and Remote Sensing: Satellites to Selfies*, VERISK (Feb. 1, 2017), https://www.verisk.com/insurance/visualize/underwriting-and-remote-sensing-satellites-to-selfies/#:~:text=Remote%20sensing%20technology%20helps%20insurers,estimate%20damage%2C%20and%20much%20more.

C. Remote Sensing Reduces Risk

The National Oceanic and Atmospheric Administration (NOAA) has developed flood mapping systems that use data and imagery from their multiple satellites and unmanned aircraft.[55] These maps are a way to measure the evolution and dynamics of flooding by providing high resolution detail over vast areas. NOAA's flood maps give first responders important information about the location and extent of the flooding, where to employ limited resources, and when it is safe for people to return to their homes.[56]

III. SHOULD BE USED BUT NOT MANDATORY

When people understand the benefits of having their land remotely sensed, then they will know for certain they are building on solid ground. Though the benefits of remote sensing are wide reaching, remote sensing should not become mandatory because it is not necessary in every situation.

For example, using a title company is not mandatory when buying or selling real property; however, in the vast majority of transactions, a title company is used.[57] This is because the relatively small cost offsets the potential losses. It is reasonable to think that the same mindset would apply to the relatively small cost of remote sensing analysis over a property.

A. Compliance: Voluntary or Mandated? The Case for Mandatory Use of Remote Sensing

Most municipalities have very stringent permitting processes for new construction and get involved in very nuanced requirements to obtain the permits required.

For context, let us examine the processes required by local municipalities to build a new home in Phoenix, Arizona. This can give us a sense of some of the local requirements to build in an average

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[55] *See Sea Level Rise Viewer*, NAT'L OCEANIC AND ATMOSPHERIC ADMIN., https://coast.noaa.gov/slr/#/layer/slr/0/-11581024.663779823/5095888.569004184/4/satellite/none/0.8/2050/interHigh/midAccretion (last visited July 9, 2023).

[56] *Id.*

[57] *Who Picks the Title Company, Buyer or Seller?*, SCOTT TITLE SERV., https://scottitle.com/who-picks-the-title-company-buyer-or-seller/ (last visited July 9, 2023).

American city. In Arizona, each time a parcel of land is bought or sold, a "Phase I" environmental inspection must be completed by a licensed company.[58] The purpose of this inspection is to look for any dangerous contaminants that may be present in the soil.[59] If dangerous contaminants are found, then additional inspections must occur, and the owner may be forced to clean the site before any development can occur.[60] Once it is determined that a parcel is free of dangerous contaminants, the sale can move forward.

The potential new homeowner must verify that his or her would-be home conforms with zoning requirements for that specific parcel.[61] If it is not zoned for a single-family residential home, then a change in zoning must first be obtained.[62] Adjusting the zoning is often a multi-year process and includes hiring attorneys who specialize in re-zoning. Once the zoning is out of the way, then a site plan must be approved. The proposed site plan shows where the house will be situated, setbacks, easements, water wells, the septic tank, the pool, etc. Once the site plans are approved, then the blueprints can be submitted for approval and then the general contractor can begin hiring subcontractors and requesting permits for electricity, natural gas, and water.

The works permits are only good for a certain period of time and so if the work is not completed in that specific time, then a permit seeking additional time can be requested.[63] If, while an inspector is at a construction site performing inspections as required by a permit, and he or she sees that other, unpermitted work is evident at the construction site, he or she will withhold granting any permits until the unpermitted work has been approved.[64]

[58] *Phase 1 Environmental Site Assessment*, GUTIERREZ-PALMENBERG, INC., https://gpieng.com/phase-i-esa/ (last visited July 9, 2023).

[59] *Id.*

[60] *Id.*

[61] *Understanding Zoning and Land Use in Arizona*, MACQUEEN & GOTTLIEB, PLC (May 6, 2019), https://www.mandglawgroup.com/2019/05/06/understanding-zoning-and-land-use-in-arizona/.

[62] *Id.*

[63] *See Plan Review & Permits*, CITY OF PHOENIX, https://www.phoenix.gov/pdd/development/permits (last visited July 9, 2023).

[64] *See Residential Permit Customers*, CITY OF PHOENIX, https://apps-secure.phoenix.gov/PDD/Permits/Instructions/8 (last visited July 9, 2023).

Many homes in Arizona use water wells to bring potable water to their homes.[65] The process of drilling a water well, installing water tanks, and the water pipes to bring water to the house is complicated and nuanced.[66] Initially, a "notice of intent to drill" must be filed with the Arizona Department of Water (ADW).[67] An employee from the ADW will perform an on-site inspection and if all goes well, then the drilling can begin.[68] The drilling must be completed by a company that has special licenses and obtains the proper permit to begin drilling.[69] Once the well is drilled, then the water must be tested by the Arizona Department of Environmental Quality.

The above steps are just a few of the many, many steps required to build a new home or otherwise make improvements on property in a typical American city. What is the core justification for requiring so many permits, licenses, and inspections? Safety! With safety as a goal, then a parcel of land should be remotely sensed at least once before a new development can be constructed, particularly in in areas that have been deemed "high risk." This information can ensure that city inspectors and planners have an extra layer of information to review before approving construction permits.

IV. CONCLUSION

Remote sensing is a modern marvel that should be used to gather more information whenever possible. The accuracy, efficiency, and cost-effectiveness of remotely sensing real property should be embraced by all of those involved in the construction, finance, insurance, and ownership of real property. The information produced can save lives, reduce risk, and bring awareness to risks. It is something that companies, governments, and individuals should require moving forward.

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[65] *Permitting and Wells Data Dashboard*, ARIZONA DEP'T OF WATER RES., https://new.azwater.gov/permitting-wells/wells-data (last accessed July 9, 2023).

[66] *Well Drilling in Arizona,* ARIZONA DEP'T OF WATER RES., https://new.azwater.gov/permitting-wells/well-drilling-arizona.

[67] *Id.*

[68] *Id.*

[69] *Id.*

DEALING WITH DEADLY DRONES: STATES HAVE RIGHTS TOO

Manny Psihountas[*]

ABSTRACT

Over the last decade, the FAA has passed regulations intending to safely integrate drone technology into the United States economy. The effect on today is that companies like Amazon are working to integrate this technology into their practice, but the impact of drone technology is likely to impact more industries than logistical ones: agriculture, construction, insurance, and infrastructure inspection are all areas expected to benefit. In passing these regulations, the FAA ensured safe usage by imposing various operational restrictions, proper licensing, and drone registration. However, there is one aspect that is lacking in this integration: the preventative measures against bad actors. Right now, the only way to report a bad actor is to call a federal agency. In order for drones to become as common as the FAA desires, the manner of addressing conflict must progress with drone use itself. If a criminal uses a drone to commit crimes in a way that poses a threat, local law enforcement must be capable of acting in a swift and decisive manner, as they are the first to respond in many situations. In order to successfully integrate this technology into the public in the long term, there must be ways to prevent bad actors from using drones as a way to shield their malfeasance. Otherwise, this progression will not be sustained.

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I. INTRODUCTION

In the late 1990s, unmanned aerial vehicles (UAVs) started to become commonplace among the United States (US) military.[1] Successes from the Israeli Forces made it apparent that drone technology offered a newfound tactical advantage. In the early 2000s, the US military discovered the benefits associated with reducing the size of UAVs;[2] such systems allowed for "quick launch and recovery, which provided real-time observational intelligence to gain a tactical advantage over an enemy."[3] Over time, the systems for these small UAVs became more sophisticated and proven, prompting the interest of civilian innovators.[4]

In the late 2000s, the spark of this new technology invigorated Congress to begin investigating the benefits this technology could have on the economy, and specifically on the commercial industry.[5] Soon after, Congress gave the Federal Aviation Administration (FAA) direct orders to begin the integration of drones into the national airspace.[6] Since receiving the go-ahead, recreational and commercial communities have adopted drone technology at an unprecedented rate.[7] Today, an array of drones are more widely available than ever at affordable price points.[8] While the impact of this technology appears propitious, as with any new technology, a new possibility of benefits accompanies a new possibility of malicious conduct.[9]

Accordingly, it is the job of Congress to ensure that the numerous administrative agencies develop reliable procedures to prevent malicious drone operation. Currently, these procedures are centralized around federal agencies, which are preempting any ability for

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[1] *See* BRET TERWILLIGER ET AL., SMALL UNMANNED AIRCRAFT SYSTEMS GUIDE: EXPLORING DESIGNS, OPERATIONS, REGULATIONS, AND ECONOMICS 16 (2017).

[2] *Id.* at 19.

[3] *Id.* at 16.

[4] *Id.* at 21.

[5] *Timeline of UAS Integration*, FED. AVIATION ADMIN., https://www.faa.gov/uas/resources/timeline/ (last updated June 2, 2022) [hereinafter *FAA Timeline*].

[6] FAA Modernization and Reform Act of 2012, Pub. L. No. 112-95, § 332 126 Stat. 73 (2012).

[7] *FAA Aerospace Forecast: Fiscal Years 2021-2041*, FED. AVIATION ADMIN. (2020), https://www.faa.gov/sites/faa.gov/files/data_research/aviation/aerospace_forecasts/FAA_Aerospace_Forecasts_FY_2021-2041.pdf [hereinafter *FAA Forecast*].

[8] TERWILLIGER, *supra* note 1, at 21.

[9] *See* Feynman, *infra* note 41.

local law enforcement to rectify a troubled situation.[10] As local law enforcement officers are the first to respond to distress,[11] the federal regulations largely preempt any action that would provide redress. This is problematic when the unlawful drone operation is of minor character;[12] but when a drone poses an imminent threat, the legal blockade preventing a first responder from efficiently mitigating a threat is unsustainable and must be fixed.

This article will provide an overview of the current state of drone technology and where the future is headed, then will highlight the diverse applications of drone technology by reviewing the beneficial impacts brought to society. After portraying this technology's ability to benefit society, the paper will reveal how that same ability can be manipulated for malicious purposes. Once the array of unlawful conduct is established, the discussion introduces the rules prohibiting such conduct, defense mechanisms to counter unlawful operation, and the laws preventing use of such defense mechanisms. The analysis concludes by illustrating the crippling effect these laws have on the ability of law enforcement to mitigate unlawful drone operation, and the changes that must be made to reinstate local law enforcement's ability to address this evolving threat to public safety. In this way, an efficient protocol will effectuate public acceptance, leading to long-term sustainable growth.

II. DRONE TECHNOLOGY

The impact of drone technology is becoming more apparent as the public continues to adopt it. Generally speaking, while new technologies bring many positive impacts to society, often overlooked is the possibility of abuse and how to deal with such newfound vulnerabilities. With this new drone technology, the downside must be understood and addressed before it can be prevented. In this way, society will be able to reap only the positive fruits of this new technology. To fully understand the impact of drone

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[10] *See Drones: A Report on the Use of Drones by Public Safety Agencies – And a Wake-Up Call about the Threat of Malicious Drone Attacks*, OFF. CMTY. ORIENTED POLICING SERVS. (2020), https://cops.usdoj.gov/RIC/Publications/cops-w0894-pub.pdf [hereinafter Police Procedures].

[11] *See* FBI, *infra* note 107 ("local and state law enforcement agencies are virtually always the first ones on the scene").

[12] By minor, the author is referring to conduct that is not imminently threatening life or property, such as trespass or breach of privacy.

technology, it is important to understand what exactly a drone is and where this technology came from.

A drone is an unpiloted aircraft referred to as an "unmanned aircraft system" (UAS).[13] This paper specifically addresses drones that are less than 55 pounds, classified as "small unmanned aircraft."[14] These aircraft are often powered by electricity ranging from batteries or solar cells; however, more expensive models are capable of being powered by small gas fueled engines.[15] Drones come in many shapes and sizes, and can be manipulated to accomplish many tasks. For instance, a readily available quadcopter drone can fly up to 45 mph, carry a payload of over 1 kg, and last 30 minutes in the air.[16] With these abilities, this drone could be used as a flying camera, to deliver a package, or many other possibilities.

Drones can change the way businesses operate and the way hobbyists enjoy technology, enabling them to see the world from a bird's-eye view. Hobbyists and commercial operators often use drones for aerial photography purposes. Photography can range from families taking overhead pictures of a backyard barbeque, to real estate agents taking pictures for a home listing, to professional videographers filming a documentary, and to anything in between.[17]

As is common with the advancement of technology, the development of the law tends to lag behind.[18] Noticing this trend in the area of drone technology, in 2008 Congress recommended the formation of an executive committee between the FAA and Department of Defense to resolve a range of issues accompanying the integration of drones into society.[19] Evidently, Congress was satisfied

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[13] Nanci K. Carr, *Look! It's A Bird! It's A Plane! No, It's a Trespassing Drone*, 23 J. TECH. L. & POL'Y 147, 150 (2019).

[14] 14 C.F.R. § 107.3 (2021) (last amended June 16, 2023). Unmanned aircrafts heavier than 55 lbs. are registered in the same manner as manned aircraft, calling for different operating regulations. David Sella-Villa, *Drones and Data: A Limited Impact on Privacy*, 55 U. RICH. L. REV. 991, 1000 (2021).

[15] *See* Carr, *supra* note 13.

[16] Matthew J. Cronin, *Crime in the Sky – Prosecuting Drone Offenses*, 69 DOJ J. FED. L. & PRAC. 255, 259-60 (2021).

[17] Carr, *supra* note13, at 151.

[18] Rachel G. McConoughey & W. Eric Richey, *Advice for When the Lone Ranger Shoots Down Your Client's Rogue Drone: Plus, Where to Not Fly Your Drone in 2019*, 30 S.C. LAW. 28, 29 (2019).

[19] *FAA Timeline*, *supra* note 5.

with the committee's findings, because in 2012, the FAA received official orders to "safely accelerate the integration of civil unmanned aircraft systems into the national airspace system."[20] After being extended in 2016 and reauthorized in 2018,[21] Congress is currently set to fund these prerogatives until 2023.[22]

Congress's desire to integrate this technology into the economy is making a noticeable impact on the drone population. Among the commercial sector, the registered drone population increased from about 12,000 in 2015 to nearly 500,000 in 2020, with the population expected to reach over 1,140,000 by 2025.[23] Recreational users have seen a similar increase in the adoption of drones: from 2015 to 2020, the recreational population increased from about 130,000 to over 1,130,000.[24] Experts predict this number may exceed 1,630,000 by 2025.[25] Early restrictions on commercial use caused drones to be more prevalent among recreational users,[26] but with the versatility of this new technology, this gap will only decrease as more commercial entities find uses for this new technology.[27] The expected impact from widespread drone adoption is truly put into perspective when understanding how they can benefit the populace.

A. Positive Societal Impact

For instance, one sector poised to prosper from integrating drone technology is agriculture.[28] The average Texas farmer owns roughly 500 acres of land, with the largest reaching 500,000.[29] When cultivating crops, each acre requires just as much care as the next. Before drone technology, farmers were required to walk

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[20] FAA Modernization and Reform Act of 2012, *supra* note 6.

[21] *See* FAA Reauthorization Act of 2018, Pub. L. No. 115-254, H.R. 302.

[22] *FAA Timeline*, *supra* note 5.

[23] *FAA Forecast*, *supra* note 7.

[24] *Id.*

[25] *Id.*

[26] *See* James L. Cresswell Jr., *Who Controls the Airspace? Issues Increase as Unmanned Aerial Systems – Drones – Fill Tennessee's Skies*, 56 TENN. B.J. 12, 13 (2020).

[27] *See FAA Forecast*, *supra* note 7.

[28] *See generally* Andy Linn, Comment, *Agriculture Sector Poised to Soar with Drone Integration, But Federal Regulation May Ground the Industry Before it Can Take Off*, 48 TEX. TECH L. REV. 975 (2016); *see also Seeing is Believing: Drones – What Are They Good For?*, ECONOMIST (June 8, 2017), https://www.economist.com/technology-quarterly/2017/06/08/drones-what-are-they-good-for [hereinafter *Seeing is Believing*].

[29] Linn, *supra* note 28, at 978.

through each acre of their harvest in order to monitor crop health – an inefficient process with high rates of error.[30] Using a drone, however, eliminates the need to walk the fields, provides better and more reliable data to the farmer, and allows for more efficient coverage of larger areas.[31] All of these factors contribute to lower cost, higher crop yield, and ultimately more profit for farmers who already work on a slim profit-margin.[32] Similarly, this process can also be used to monitor pollution among lakes, thus lowering the environmental impacts of farming.[33] While agriculture is poised to see a noticeable impact from drones, other sectors expected to benefit similarly are construction, insurance, and infrastructure inspection.[34]

At the moment, drones are primarily used as flying cameras,[35] but various other applications are continuing to evolve as the technology becomes more widespread. One alternative function is seen in the field of logistics. In the mid-2010s, drone performance was tested by delivering medical supplies to hard-to-reach areas and delivering food to a community in North Carolina,[36] foreshadowing what was to come on a larger scale over the next decade. Today, big companies like Amazon.com, Alphabet, UPS, and Domino's are investing in the future of drone delivery, and this is just the tip of the iceberg.[37] In a society that thrives on competition,[38] as more big companies adopt this technology, it will only induce others to do the same.

The widespread adoption is expected to positively impact the economy as a whole. Comprehensively, integration of drone technology is expected to produce an increase of $82 billion in gross

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[30] *Id.*

[31] *Id.*

[32] *See id.*

[33] *Id.* at 981.

[34] *Commercial Drones Are the Fastest-Growing Part of the Market*, ECONOMIST (June 8, 2017), https://www.economist.com/technology-quarterly/2017-06-08/civilian-drones.

[35] *Seeing is Believing*, supra note 28.

[36] *FAA Timeline*, *supra* note 5.

[37] *Why Amazon, UPS, and Even Domino's Is Investing in Drone Delivery Services*, INSIDER INTEL. (Jan. 1, 2023), https://www.insiderintelligence.com/insights/drone-delivery-services/.

[38] *See generally* Heather Boushey & Helen Knudsen, *The Importance of Competition for the American Economy*, WHITE HOUSE (July 9, 2021), https://www.whitehouse.gov/cea/written-materials/2021/07/09/the-importance-of-competition-for-the-american-economy/.

domestic product and nearly 100,000 new jobs.[39] The increased efficiency is likely to result in total savings of over $100 billion.[40] With such incredible impacts on the economy, it seems like nothing could go wrong … until it does.

B. Bad Actors & Drone Technology

Richard Feynman, infamous theoretical physicist from the California Institute of Technology, once quoted a Buddhist Proverb, "[t]o every man is given the key to the gates of heaven; the same key opens the gates of hell."[41] Feynman, who spent time working on the Manhattan Project,[42] was speaking to the belief that scientific progress can produce great horror in the world, while simultaneously producing incredible benefits.[43] The same is true for the progress of engineering,[44] and specifically, the widespread adoption of drone technology. The many positives brought to society also coincide with much potential for abuse by bad actors. "Just as an entrepreneur can use a drone to provide security, deliver goods, and assist in life-saving emergency services, so too can an enterprising criminal use it to terrorize airports and public venues, smuggle contraband, and create a mass-casualty event."[45] With drone operations, these potential abuses come in the form of a shield – an extra layer of protection making it more difficult to locate and identify a

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[39] ASS'N UNMANNED VEHICLE SYS. INT'L, THE ECONOMIC IMPACT OF UNMANNED AIRCRAFT SYSTEMS INTEGRATION IN THE UNITED STATES, (2013), https://robohub.org/_uploads/AUVSI_New_Economic_Report_2013_Full.pdf.

[40] U.S. DEP'T. OF TRANSP., INTEGRATION OF CIVIL UNMANNED AIRCRAFT SYSTEMS (UAS) IN THE NATIONAL AIRSPACE SYSTEM (NAS) ROADMAP (1st ed. 2013), https://www.faa.gov/uas/resources/policy_library/media/uas_roadmap_2013.pdf.

[41] Richard Feynman, *The Value of Science*, 19 ENG'G & SCI. 13 (1955), https://calteches.library.caltech.edu/1575/1/Science.pdf.

[42] After the start of the Second World War, Feynman was recruited to the Manhattan Project where he contributed to the development of the atomic bomb – scientific development which clearly produced great horror but also furthered science in many ways. *See Richard Feynman*, WIKIPEDIA, https://en.wikipedia.org/wiki/Richard_Feynman (last visited June 24, 2023).

[43] *See* Feynman, *supra* note 41.

[44] Any new technology can be used for both good and bad purposes. Using the realm of computer science as an example, Facebook was created as a social media platform to connect people, and now it has the power to sway elections. *See generally* Seth Fiegerman, *Facebook Is Well Aware That It Can Influence Elections,* CNN (Nov. 17, 2016), https://money.cnn.com/2016/11/17/technology/facebook-election-influence/.

[45] Cronin, *supra* note 16, at 271.

perpetrator. The various transgressions capable of being committed by a drone fall into two categories: logical attacks or physical attacks.[46]

Logical attacks include instances of a drone attacking the network of a given location.[47] In this way, drones can be manipulated to capture passwords, credit card numbers, and other sensitive data.[48] Researchers in Singapore displayed this ability by attaching a cell-phone to a drone in order to set up an open Wi-Fi network; they flew the drone up the side of a building to the thirtieth floor next to where a printer was located, and proceeded to intercept confidential documents that were being sent to print.[49] Cyberespionage is already a frightening reality,[50] as the victim rarely knows of the damage taking place; the use of drones adds another dimension to this silent battle for electronic privacy.

Physical attacks cover those abuses that do not attack one's network, relying more on the kinetic aspect of drone operation.[51] This is most commonly seen in the form of physical privacy invasion[52] – using a drone camera to spy on someone or something:

> [T]he incredibly accurate, detailed imagery and other remotely sensed data obtainable by small drones poses an additional risk to critical infrastructure. The unique perspective offered by a drone operating at up to several hundred feet, coupled with high-resolution stabilized cameras, allows anyone to obtain detailed data for critical infrastructure, such as dams, electrical transmission systems, power generation facilities, airports, public safety agencies and assets, and military hardware locations.[53]

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[46] Jean-Paul Yaacoub et al., *Security Analysis of Drones Systems: Attacks, Limitations, and Recommendations,* NAT'L CTR. FOR BIOTECH. INFO. (May 8, 2020), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7206421/.

[47] *Id*.

[48] *Id*.

[49] Joseph J. Vacek, *Counter-UAS Applications Illegal Under 18 U.S.C. § 32 Are Justified When Using a Reasonably Defensible Counter-UAS Strategy That Incorporates Risk and Compliance Categorizations*, 93 N.D. L. REV. 499 (2018).

[50] *See Google v. Joffe*, 746 F.3d 920 (9th Cir. 2013) (finding Google liable for using its automated street cars, which collect data and take imagery for Google Earth "Street View," to simultaneously collect data from any unencrypted Wi-Fi networks with which the car would come in contact).

[51] Yaacoub, *supra* note 46.

[52] *Id*.

[53] Vacek, *supra* note 49, at 504.

Drones can be "whisper quiet," and when high enough, are "undetectable to the human eye."[54] Therefore, as with logical attacks, victims may similarly be unaware of the damage being done. Another form of physical attack and an "increasingly common tactic" is using drones to smuggle and distribute contraband, whether that be across the US border or over a guarded fence into prisons.[55] However, perhaps the most severe type of physical attack derives from the integration of drone technology and serious weaponry. For instance, in *Huerta v. Haughwout*, the FAA investigated a father and a son who posted YouTube videos of their drone-weapon creation: one drone attached to a handgun and the other to a flamethrower.[56] The mere ability to manipulate drone technology in such a manner illustrates the magnitude of damage that can be done by someone with bad intentions.

All in all, drones clearly have plenty of positive aspects, but they also carry potential for problems. It is the job of Congress and such authorized agencies to ensure that the integration of this technology is not manipulated into being a Trojan horse for lawlessness. Congress must ensure that the first responders to a drone-related incident are not crippled by needless legal restrictions.

III. LEGAL FRAMEWORK OF DRONE INTEGRATION – OPERATIONAL REGULATIONS

With the downside of drone use established, it is important to understand the rules governing operation to better visualize how this technology is being integrated into society. Once it is established what the law allows, then it is easier to understand where the law fails. The FAA heavily regulates the operation and registration of drones. Before flying, every drone must be registered in the FAA's database.[57] Following this process, the FAA will then issue a registration number that must be displayed on the outside of the drone.[58] Further, when flying the drone, every operator must have proof of registration available at all times.[59] In 2023, an FAA

[54] Cronin, *supra* note 16, at 271.
[55] *Id.*
[56] *Huerta v. Haughwout*, No. 3:16-cv-358, 2016 WL 3919799 (D. Conn. July 7, 2016).
[57] 14 C.F.R. § 107.13.
[58] *Id.*
[59] 14 C.F.R. § 107.7.

regulation will become effective which mandates every drone to be remotely identifiable, so innocent bystanders can distinguish good-faith operators from the mischievous.[60] This information will provide bystanders with a drone's identity, location, altitude, and its control station or take-off location.[61]

As far as operating a drone, the broadest rules governing operation require the operator to not use the drone in a "careless or reckless manner so as to endanger the life or property of another," and to not "allow an object to drop from the aircraft in a way that creates undue hazard to persons or property."[62] In practice, this essentially obligates the operator to act reasonably. More specific requirements bind an operator to only controlling one drone at a time,[63] prohibit operation while under the influence of drugs or alcohol,[64] and obligate "the person manipulating the flight controls" to maintain the drone within his or her line of sight.[65]

The regulations passed by the FAA sufficiently prohibit the possibilities for wrongdoings. The operational requirements limit operation in situations that may cause an accident, and the registration requirements aid to document every entity operating in the sky. On one hand, this may progress toward more efficient law enforcement and create better acceptance from the public. On the other hand, a sad truth of today is that any number of laws only stop the rule-followers,[66] and those law-abiding individuals are unlikely to perform the bad acts that are possible with drone technology. While this is true for all bad acts, outside of drone technology, police are in a position to prevent the malfeasance – like an officer patrolling a mall to dissuade theft. In this scenario, theft is dissuaded because people know that an officer is capable of addressing the thief if he or she were to act. However, when the bad act is committed via a drone, police are preempted from addressing the

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[60] *Remote Identification*, FED. AVIATION ADMIN., https://www.faa.gov/uas/getting_started/remote_id (last updated June 29, 2023).

[61] *Id*.

[62] 47 C.F.R. § 107.23.

[63] 47 CFR § 107.35.

[64] 47 CFR § 107.27.

[65] 47 CFR § 107.31.

[66] *See* Cronin, *supra* note 16, at 257 ("drone misuse has also 'increased dramatically over the past two years,' with the FAA receiving over 100 reports of errant drones [per] month").

transgression in an efficient manner; therefore, no bad act is dissuaded. To dissuade bad actors from performance, there must be more than the threat of retribution from breaking the law – there must be preventative measures available to stop them from doing it in the first place.

IV. DRONE DEFENSE

If one witnesses a drone being operated in an unlawful manner, it is pertinent to understand what options are available to rectify the situation. One would assume that the best recourse is to notify local law enforcement; however, when it comes to drone operation, local law enforcement is preempted from action in many ways.[67] With a public that is largely reliant on local law enforcement to aid in troubled situations,[68] this causes problems. This section delves into the various technological resources to detect and mitigate drone technology, and the legal regime's inimical effect on law enforcement's ability to provide redress.

A. Technological Possibilities

Technology is a two-way street: just as technology may allow a criminal to perform a bad act through a drone, technology also may find a way to prevent a criminal from committing such acts. This article will refer to preventative technology and other counter-drone methods as 'defense techniques.' The effects of the various techniques are further divided into two categories: detection and mitigation. Detection works to identify and communicate the location of a drone when intruding into a particular vicinity, while mitigation works to actively interrupt the operation of the drone.

i. Detection Techniques

Drone detection comes in two forms: radiofrequency and non-radiofrequency. Non-radiofrequency systems detect the physical presence of a drone or the signals being sent from the drone, but do

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[67] *See generally* Police Procedures, *supra* note 10.

[68] *See generally* Heather Mac Donald, *Why We Need the Police*, CITY J. (June 8, 2020), https://www.city-journal.org/why-we-need-the-police.

not "record" the signals detected.[69] These systems come in the form of radar-based systems, acoustic systems that "hear the drone," and also thermal imaging cameras.[70] Radiofrequency systems identify the radio signals from the drone, and proceeds to "record" the signals to calculate the location of the controller.[71] Non-frequency systems are legal and available to the public; however, the use of radiofrequency systems to locate the controller is prohibited.[72] Such systems violate the Pen/Trap Statute and Wiretap Act for capturing and recording electronic communications.[73] There is no exception for private actors; thus, law enforcement may use such devices only with a court order.[74] This is only given if necessary for the furtherance of an ongoing criminal investigation.[75]

Detection techniques may be useful for citizens who desire to know when a drone is intruding on their property; however, to prevent a drone from intruding in the first place requires use of a mitigation technique.

ii. Mitigation Techniques

There are four realistic methods to mitigating drone technology, most of which are frowned upon by the law because drones are entitled to fly in national airspace.[76] The four categories are spoofers, hackers, jammers, and destroyers.[77] Each works in a distinct way to interrupt the operation of the drone.

Spoofers work by manipulating and altering the signals between the remote operator and the drone itself.[78] This can be done by interfering with the sensor measurements of position, time, or

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[69] FED. COMMC'NS COMM'N ET AL., ADVISORY ON THE APPLICATION OF FEDERAL LAWS TO THE ACQUISITION AND USE OF TECHNOLOGY TO DETECT AND MITIGATE UNMANNED AIRCRAFT SYSTEMS (2020), https://docs.fcc.gov/public/attachments/DOC-366222A1.pdf [hereinafter INTERAGENCY ADVISORY NOTICE].

[70] Police Procedures, *supra* note 10.

[71] *See id. See also* INTERAGENCY ADVISORY NOTICE, *supra* note 69.

[72] Police Procedures, *supra* note 10.

[73] INTERAGENCY ADVISORY NOTICE, *supra* note 69.

[74] *Id.* (citing 18 U.S.C. §§3122(b)(2) & 3121(c)).

[75] *Id.*

[76] *See* 18 U.S.C. § 32 (1999) (destruction of aircraft or aircraft facilities).

[77] *See* Jonathan Rupprecht, *Big Problems with Counter Drone Technology (Anti Drone Guns, Drone Jammers, Etc.)*, RUPPRECHT L. P.A. (May 21, 2023), https://jrupprechtlaw.com/drone-jammer-gun-defender-legal-problems/.

[78] *Id*.

velocity; ultimately causing the controller to lose control of the drone.[79] Hacking a drone is similar to spoofing, but taken to a further extent – interfering with the position, time, and velocity signals in such a way as to completely hijack operation away from the controller.[80] Alternatively, frequency jamming works to send a stronger signal on the same radio frequency as the one used between the controller and the drone, which overpowers and disrupts the incoming signal[81] – essentially causing the drone to fall out of the sky. Lastly, a destroyer is the category representing the "old fashioned" approach to drone mitigation: physical destruction by force, such as using a baseball bat or a firearm.[82]

Broadly speaking, local authorities are outlawed from taking such action under 18 U.S.C. § 32 which prohibits the destruction, damage, or disabling of any aircraft within the jurisdiction of the United States.[83] Moreover, the technological responses are outlawed by 18 U.S.C. § 1030: prohibiting instances of "accessing a protected computer without authorization and thereby obtaining information, or intentionally damaging a protected computer without authorization, including by transmitting a program, information, code, or command that causes such damage."[84] With jammer technology it is not just illegal to possess[85] – it is also illegal to manufacture, import, market, or sell the operation of an unlicensed jammer in the United States, thus making its use further from becoming a realistic possibility.[86]

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[79] Yaacoub, *supra* note 46. *See also* Shah Zahid Khan et al., *On GPS Spoofing of Aerial Platforms: A Review of Threats, Challenges, Methodologies, and Future Research Directions*, PEERJ COMP. SCI. (May 6, 2021), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8114815/.

[80] *Id*.

[81] Vacek, *supra* note 49, at 513.

[82] *See* Rupprecht, *supra* note 77. An exception carved out in 6 U.S.C. § 124n allows the Secretary of State and Attorney General to authorize personnel to destroy aircraft, notwithstanding 18 U.S.C. § 32. This exception has been granted to few federal agencies but is not extended to state law enforcement.

[83] 18 U.S.C. § 32.

[84] INTERAGENCY ADVISORY NOTICE, *supra* note 69 (citing 18 U.S.C. § 1030). There are additional statutes that may prohibit such conduct, but these are the primary focal points listed in the Interagency Advisory Notice.

[85] *Jammer Enforcement*, FED. COMMC'NS COMM'N (April 2020), https://www.fcc.gov/general/jammer-enforcement [hereinafter *Jammer Enforcement*].

[86] 47 U.S.C. § 302(b). It is worth noting that these techniques are not prohibited against the public needlessly and many of them cause unintended consequences. For instance, use of a frequency jammer is only legal when given a license from the FCC

B. Dealing with Unlawful Drones – Minor Threats

With the amalgam of legal barriers preventing disarming action on a drone, what is one to do if one comes in contact with a bad actor? The law allows for use of a mitigation technique by providing justifications for either defense of property or self-defense.[87] To be justified, the actions of defense must be reasonable in scope to the threat posed.[88] When dealing with minor infractions,[89] this poses the problem of knowing what exactly constitutes unlawful conduct so as to know what is threatening. However, when the rules forbidding certain conduct are ambiguous, this places a substantial burden on everyday laypersons. For instance, in the scenario of a simple trespass with a drone, the "threat posed" may be mitigated by a request to the operator to desist from entering one's property.[90] If the trespasser persists, use of a counter-drone technique may be justified. In any trespass scenario, however, the landowner must be aware of the airspace delineations to know whether the drone was trespassing in the first place.

i. Airspace

According to the US Congress, the federal government has "exclusive sovereignty of the airspace in the United States."[91] This authority was then delegated to the FAA to "develop plans and policy for the use of the navigable airspace…"[92] In using this power to regulate, the FAA clearly established a ceiling for permissible drone travel in 14 C.F.R. § 107.51, which mandates that a small unmanned aircraft must not exceed "400 feet above the ground."[93] However, when dealing with the minimum altitude over private property, the lines are not quite as clear.

In the common law, delineation of airspace followed the ancient doctrine of *cujus est solum ejus esque ad coelom* – "whoever

because use of such may interfere with other devices reliant on radio waves like cell phones. *See id.*

[87] Vacek, *supra* note 49, at 507.

[88] *Id*.

[89] Referring to the unlawful use of drones that do not pose an imminent threat to life or property.

[90] Vacek, *supra* note 49, at 514.

[91] 49 U.S.C. § 40103(a)(1).

[92] 49 U.S.C. § 40103(b)(1).

[93] 14 C.F.R. § 107.51 (2016).

owns the soil, it is theirs up to Heaven."[94] In the wake of technological progress, lawmakers deviated from this idea – seeing it as incompatible with modern airplane travel.[95] When faced with the revolutionary issue of airspace delineation in the wake of technology, the United States Supreme Court held in *Causby* that landowners have "exclusive control of the immediate reaches of the enveloping atmosphere" and "the landowner owns at least as much of the space above the ground as he can occupy or use."[96] Further, in *Singer*, the District Court of Massachusetts invalidated a law that prohibited unauthorized drone use up to 400 feet above private property, finding that it was preempted by Congress's intent to regulate the airspace.[97]

Synthesizing these two holdings: a drone cannot be prevented from flying 400 feet above private property,[98] but can only go low enough as to not interfere with the landowner's enjoyment and use. In the scenario of a distressed landowner contemplating proper recourse, these lines are as fuzzy as lines can be. In *Boggs*, a district court in Kentucky was faced with this exact dilemma: a trespassing drone and a civilian who took matters into his own hands by shooting it down with a shotgun.[99] The plaintiff argued that he was in navigable airspace, but the defendant claimed the drone was on his property.[100] The federal court ended up dismissing the case for lack of subject matter jurisdiction, ruling that the FAA had not sought to enforce such regulations in this case, but left the door open for a cause of action in state court.[101] However, in *Commonwealth v. Merideth*, the Kentucky state Judge ruled that the defendant had the

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[94] TIMOTHY M. RAVICH, INTRODUCTION TO AVIATION LAW 62 (2020).

[95] *Id.*

[96] Carr, *supra* note 13, at 158 (citing *United States v. Causby*, 328 U.S. 256, 258 (1946)).

[97] *Singer v. City of Newton*, 284 F.Supp.3d 125, 131 (D.Mass. 2017).

[98] This assumes that other jurisdictions fall in line with the Court in *Singer*. It is certainly possible that other jurisdictions differ on finding conflict or field preemption with regards to federal airspace laws. A finding of conflict preemption would permit airspace regulations from the states so long as it does not conflict with the federal regulations, while a finding of field preemption would not allow any state regulations regarding airspace.

[99] *See Boggs v. Merideth*, No. 3:16-CV-00006-TBR, 2017 WL 1088093 (W.D. Kent.).

[100] *Id.*

[101] *Id.*

right to shoot down the drone.[102] Despite the *Boggs* and *Merideth* holdings in favor of landowners' rights, the outcome was not clear-cut and could have ended poorly for the defendant.

ii. Recourse

To avoid the risk of unlawful action against a drone in a trespass situation, one typically notifies local law enforcement.[103] However, the ability for law enforcement to rectify the situation is crippled. The Preventing Emerging Threats Act of 2018, a subsection of the FAA Reauthorization Act of 2018, only gives certain authorized personnel the power to disable a drone, ultimately preempting local law enforcement from taking such action.[104] On the flipside, when merely locating an operator, law enforcement is prohibited from using radiofrequency detection systems that would efficiently gather such information.[105] This means that local law enforcement could find itself powerless to counter the whims of an anonymous drone operator.

Imagine a scenario where a citizen continually bothered by a drone does the right thing and calls law enforcement. If the police walk around the vicinity and cannot physically locate the operator, there is no *immediate* assistance that the officer can give; the officer cannot disable or interfere with the operation of the drone, and the officer cannot use radiofrequency technology to locate the perpetrator. The only recourse is to get a court order to detect the operator, or call a federal agency to disable the drone. This is not efficient and will lead more citizens to take matters into their own hands – perhaps in an unsafe way as seen in the *Boggs* case.

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[102] *Judge Dismisses Charges for Man Who Shot Down Drone*, WRDB.COM (Oct. 26, 2015), https://www.wdrb.com/news/judge-dismisses-charges-for-man-who-shot-down-drone/article_b52eff9b-0c87-53ce-ad68-38806c7c9288.html (updated June 7, 2023).

[103] *See How to Charge Someone With Trespassing*, FAIR PUNISHMENT, https://fairpunishment.org/how-to-charge-someone-with-trespassing/ (last visited June 25, 2023) ("The first step is to contact the police. A trespasser is in violation of the law and should be reported to the police immediately").

[104] *See* 6 U.S.C. 124n – Protection of certain facilities and assets from unmanned aircraft.

[105] *See id*. *See also* INTERAGENCY ADVISORY NOTICE, *supra* note 69.

C. Dealing with Imminent Threats

The handicapping of local law enforcement is more worrisome when such unlawful conduct poses an imminent threat. An example of a drone posing as an "imminent threat" is seen in the hit television show "Criminal Minds," wherein the perpetrator attaches an automatic firearm to a drone, and proceeds to commit atrocities at mass gatherings.[106] If a civilian comes across this type of conduct, typically the first reaction is to call 911, which initially summons local and state law enforcement officials.[107] However, what are the first responders going to do? This is the crux of the issue. When the threat posed is imminent, action from a first responder to neutralize the threat likely falls under the self-defense exception.[108] When evaluating the readily available methods of recourse, presumably, a first responder's instinct would be to try and shoot it down.[109] This is not an efficient response, especially in a setting where misfires can increase injuries. An efficient response would be for the first responders to arrive with jamming technology to immediately interrupt the radio communications between the controller and the drone. This would cause the drone to fall out of the sky instantaneously and would be more effective than attempting to shoot it down. However, just as the technology is outlawed in the general public, it is similarly outlawed in the hands of the first responders – law enforcement is just as handicapped as civilians.[110]

If this scenario came to fruition, the only response from law enforcement is to call a federal agency, likely the FAA or

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106 *Criminal Minds: Killer App* (CBS television broadcast Oct. 18, 2017).

107 *See First Responder Toolbox: Malicious Modification of UAS*, OFF. DIR. NAT'L INTEL. (Sept. 16, 2020), https://www.dni.gov/files/NCTC/documents/jcat/firstresponderstoolbox/First_Responders_Toolbox_-_Unmanned_Aircraft_System_UAS-_Recognizing_Malicious_Modification-survey.pdf (recommending to "call 911 for observed UAS activity placing individuals or facilities in immediate danger"); *see also Active Shooter Resources*, FED. BUREAU INVESTIGATION, https://www.fbi.gov/about/partnerships/office-of-partner-engagement/active-shooter-resources (last visited June 24, 2023) ("local and state law enforcement agencies are virtually always the first ones on the scene") [hereinafter FBI].

108 Vacek, *supra* note 49, at 507.

109 Out of all of the possible mitigation techniques available to a first responder, the author assumes that use of the firearm would be the most readily available option.

110 Jamming technology is only permitted when granted a license by the FCC prior to use. This technology is rarely even attempted to be marketed to law enforcement because sellers know that officers are prohibited from obtaining such technology in majority of cases. *See* Police Procedures, *supra* note 10.

Department of Homeland Security.[111] An imminent threat requires a timely response, which is unlikely to come from a federal agency.[112] Additionally, if the first responders are unable to mitigate the threat, then there is no barrier preventing malicious drone use from affecting the public. Mandating this response is inefficacious and will eventually cripple the growth of drone technology.

In order for drone technology to thrive, it must be accepted by the public. Public acceptance is more likely when the downside of drone technology is actively prevented, allowing the public to reap only the positive effects of this technology. The public traditionally relies on local law enforcement to prevent malicious acts and to assure its safety.[113] This feeling of safety derives from the presumption that law enforcement officials are actually capable of mitigating the various threats that may be posed. For instance, if a criminal breaks into a house and the homeowner calls the police, this is likely a result of believing that the police are capable of neutralizing the threat. However, in the integration of this new technology, the threats facing the public are evolving, while the legal regime preempts the backbone of public safety from evolving to stop them.

The FAA is doing a sufficient job of integrating drones into society with proper regulations and rules, but this has little effect on the criminals within society. In order to deal with the evolving methods of committing crimes, threat prevention responsibilities cannot be centralized to federal agencies. Local law enforcement is the best equipped to respond to imminent threats, and there must be efficient procedures set in stone before one actually takes place.

V. SOLVING THE DRONE DILEMMA

The flaws associated with drone integration can be fixed with just a few modifications to the laws currently standing in the way. The problem, in essence, is that Congress began integrating drone technology into society for the numerous economic and societal

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111 *See* Police Procedures, *supra* note 10; *See generally Protecting Against the Threat of Unmanned Aircraft Systems*, INTERAGENCY ADVISORY COMM. (Nov. 2020), https://www.cisa.gov/sites/default/files/publications/Protecting%20Against%20the%20Threat%20of%20Unmanned%20Aircraft%20Systems%20November%202020_508c.pdf.

112 *See* FBI, *supra* note 107 ("local and state law enforcement agencies are virtually always the first ones on the scene").

113 *See* Mac Donald, *supra* note 68.

benefits, all while not properly acknowledging the new dimension of possible misconduct. This is acknowledged on the federal level, but essentially preempts any acknowledgement from the states.[114] Law enforcement at the local and state level is the backbone that public safety relies upon to guard against bad actors.[115] However, law enforcement is preempted from taking effective action against unlawful conduct that materializes through drone operation.[116] This is neither efficient nor likely to lead to the prosperous integration of drone technology. Rectifying this situation lies in expanding exceptions within the legal barriers preempting defense techniques.

The broadest law preempting action lies in 18 U.S.C. § 32, prohibiting the destruction, damage, or disabling of any aircraft.[117] Notwithstanding, federal agencies are given the power to mitigate threatening drones under the Preventing Emerging Threats Act of 2018.[118] Accordingly, preemption must first be nullified by expanding the Preventing Emerging Threat Act to include state law enforcement officials. Federal agencies are incredibly busy and only have a certain amount of bandwidth. Alternatively, rather than extending the exception, a similar outcome can be reached by excluding small unmanned drone technology from the definition of an aircraft, thus removing it from the whims of 18 U.S.C. § 32. Regardless of how the ultimate goal is reached, the burden of dealing with numerous trivial matters from across the country is decreased by giving local law enforcement the ability to take the proper action. Allocating authority to state officials will increase faith in law enforcement to remedy a situation, which in turn disincentivizes citizens from taking actions in unsafe ways.[119]

The next law preempting meaningful action can be avoided by expanding the law enforcement exception within the Pen/Trap Statute. Currently, if law enforcement cannot physically locate the drone operator, it must retain a court order to use the radiofrequency detection system that would reveal such location. This is too high of a burden to bear and will chip away at citizens' confidence

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[114] *See* INTERAGENCY ADVISORY NOTICE, *supra* note 69 (referencing the Preventing Emerging Threats Act, 6 U.S.C. § 124n (2018)).

[115] *See id. See also* FBI, *supra* note 107.

[116] INTERAGENCY ADVISORY NOTICE, *supra* note 69.

[117] 18 U.S.C. § 32.

[118] Preventing Emerging Threats Act, 6 U.S.C. § 124 (2018).

[119] *See* the discussion about *Boggs v. Merideth* in section IV(b)(ii).

in law enforcement to address unlawful conduct. Rather, if a local law enforcement official *reasonably believes* a drone to be operating unlawfully, then use of radiofrequency detection systems should be permitted. This will be most impactful in 2023, after the remote identification mandates go into effect.[120] Then, if local enforcement finds that an operator is unable to be identified,[121] that would reveal *prima facie* evidence of unlawful conduct, and radiofrequency detection systems should be readily available to locate the operator.[122]

Detection systems will greatly aid in the minor infractions posed by drones; however, the major threats possible with drone technology require ensuring that first responders have access to a mitigation technique to efficiently disable any threat. The readily available defense to an imminent threat should be proportionate to the severity of the threat posed. However, currently "[l]ocal law enforcement agencies do not have independent authority to use jamming equipment,"[123] so the threat can surpass any defense available. In the event of a major threat, time is of the essence;[124] allowing for limited use of frequency jammers only in these severe situations will allow for an efficient response. This ability can be given to local law enforcement by conditionally expanding the license for legal jammer use, the condition providing for use only in severe situations. Regarding a state law enforcement's right to use jammers: it

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[120] This remote identification requirement would give law enforcement and federal agencies instant access *supra* note 60.

[121] Any wireless communications device that is within range will be able to detect the serial number of the drone, but the registration corresponding to the serial number is kept by the FAA. This information is given to law enforcement after a formal request. *See Executive Summary: Final Rule on Remote Identification of Unmanned Aircraft*, FED. AVIATION. ADMIN. (Dec. 28, 2020), https://www.faa.gov/sites/faa.gov/files/2021-08/RemoteID_Executive_Summary.pdf. If law enforcement is unable to detect a serial number, then the operator cannot be identified.

[122] Especially in the early years, the penalties for such conduct should be incredibly trivial, if at all. The goal should be to merely create awareness of this law so good faith operators achieve compliance, and those bad faith operators can be located.

[123] *Jammer Enforcement*, *supra* note 85.

[124] A short response and engagement time leads to less casualties in an active shooter situation. *See* Keily Linger, Honors Thesis, *Analysis of the Police Response to Mass Shootings in the United States Between 1966 and 2016*, UNIV. AT ALB.: EMERGENCY PREPAREDNESS, HOMELAND SEC., AND CYBERSEC. (May 4, 2018), https://scholarsarchive.library.albany.edu/cgi/viewcontent.cgi?article=1000&context=honorscollege_ehc ("the relationship between the shooting duration and the total number of casualties … was considered statistically significant").

is better to have this technology and to not use it, than to be preempted from efficiently protecting its community if the time comes.

VI. CONCLUDING REMARKS

Drones are becoming more widespread, but they are not near the peak of public adoption.[125] The impact of this new technology is poised to bring considerable positive impacts to society, and this should be cherished. However, in order to preserve the benefits, Congress must properly address the new possibility for unlawful conduct. This is done by giving the heroes who preserve public safety the power to sufficiently address a drone-related incident. In any community, the authorities relied on are almost always state and local officials—as they are the first to respond to a cry for help.[126] By having adequate procedures in place before a drone-related incident occurs, Congress can preserve and maintain a positive public perception of this new technology, allowing such benefits to flourish in society for many years to come.

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[125] *See Drone Market Outlook in 2022: Industry Growth Trends, Market Stats and Forecast*, BUS. INSIDER (Jan. 7, 2023), https://www.businessinsider.com/drone-industry-analysis-market-trends-growth-forecasts. The market for drone technology passed $1.25 billion in 2020, and Goldman Sachs forecasts it to eventually be worth $100 billion.

[126] FBI, *supra* note 107.

THE UNIVERSITY OF GUAM DRONE CORPS PROGRAM: PAVING THE WAY FOR THE FUTURE OF AN ISLAND COMMUNITY'S DRONE INDUSTRY

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The University of Guam (UOG) Drone Corps program aims to meet the growing demand for trained and licensed drone pilots in Guam's heavily regulated airspace. Drones have become essential tools for researchers, addressing projects such as surveying coral reefs and monitoring water supply. The program, launched in April 2021, is a collaborative effort between NASA Guam Space Grant (NGSG) and NASA Guam Established Program to Stimulate Competitive Research (EPSCoR). The Drone Corps aims to build technical capacity by producing informed, responsible, and FAA-licensed drone pilots. The program provides members with FAA Part 107b examination preparatory knowledge courses, hands-on

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flying experience, and stipends. After certification, students fulfill 40 hours of flight time through missions assisting UOG researchers, local government agencies, and nonprofit organizations.

The program's inaugural cohort faced challenges during the COVID-19 pandemic but adapted to provide a structured curriculum and partnered with local UAS companies for resources. By training and certifying drone pilots, the UOG Drone Corps program contributes to the development of Guam's drone industry, prepares students for future careers, strengthens relationships between UOG and local agencies, and promotes responsible drone use and education.

I. INTRODUCTION

On the island of Guam, an unincorporated territory of the United States located in the western Pacific, unmanned aircraft systems (UAS) or unmanned aerial vehicles (UAV) have been critical tools for local researchers in surveying, mapping, gathering data, and visualizing areas of the island that would otherwise be too difficult to reach on land. For many of these projects, researchers use drone technology to address the island's unique challenges and environments from new heights, with past and upcoming projects focused on mapping offshore coral reefs,[1] repairing eroded lands,[2] and surveying the local aquifer's water supply.[3] In recent years, the use of drones has begun to expand outside of the academic sector, extending to recreational areas such as cinematography, photography, and entertainment displays. During the island's 77th Liberation Day, for instance, the local community celebrated the landmark event with the island's first-ever public light drone show.[4] As the need for this service continues to grow in both

[1] Andrew Silver, *Drone Takes to the Skies to Image Offshore Reefs*, 570 NATURE 545 (2019). https://www.researchgate.net/publication/334005906_Drone_takes_to_the_skies_to_image_offshore_reefs.

[2] *UOG Repairing Hard to Reach Eroded Lands with Drones*, KUAM NEWS (May 22, 2021), https://www.kuam.com/story/43939297/uog-repairing-hard-to-reach-eroded-lands-with-drones.

[3] *UOG Awarded $715K for Research on Aquifer and Coral Reef Health*, UNIV. OF GUAM, (Sep. 19, 2021), https://www.uog.edu/news-announcements/2021-2022/2021-715k-awarded-for-uog-research-into-aquifer-and-coral-reef-health.php.

[4] Steve Limtiaco, *Liberation Drone Light Show a First for Guam*, PAC. DAILY NEWS, (July 20, 2021), https://www.guampdn.com/news/liberation-drone-light-show-a-first-for-guam/article_5e0d170c-e8f0-11eb-8e03-bf5fc3ec25b1.html.

academic and recreational capacities, so too will the number of certified drone flyers.

Due to the island's status as a territory, much of Guam's drone regulations and restrictions comes from the United States via the Federal Aviation Administration (FAA) and the Department of Defense (DOD) rather than a local governing body (see Appendix A). The FAA requires drone registration for both recreational and commercial uses. In some cases, access to certain airspace requires proof of a registered drone. This accountability measure was established to help prevent flight accidents, privacy violations, and criminal activity in secured areas.

On a local level, there are currently no Guam-issued laws that detail specific restrictions on the use and conduct of drones. Recreational users are not required to obtain any local permit to fly their personal devices. Commercial users must have a permit for their drone equipment as it is part of their services or products.[5] Most recently, Public Law 35-118, which was signed into law on December 11, 2020, helped establish an opportunity for a commercial drone industry to develop on the island.[6] The passing of this law indicates that the industry is still in its developmental stages with opportunity for future growth. Drone flight restrictions from the A.B. Won Pat International Airport and two of the island's military bases, Andersen Air Force Base (AAFB) and Naval Base Guam (NBG), as well as their adjacent federal properties, account for a majority of Guam's airspace.[7] In August 2021, when the U.S. Attorney's Offices for the Districts of Guam and the Northern Mariana Islands hosted a virtual discussion with FAA agents on drone usage, FAA Special Agent Michael Bumberger stated that more than two-thirds of the island's airspace is either restricted or requires approval before flight.[8] He also noted that many UAS operators are

[5] *Guam Drone Laws*, UAV SYS. INT'L, https://uavsystemsinternational.com/pages/guam-drone-laws#:~:text=A%20permit%20is%20required%20for,contact%20the%20local%20aviation%20authority (last visited July 7, 2023).

[6] Act of Dec. 11, 2020, Pub. L. No. 35-118, 35th Guam Leg., Bill Status (2020), https://www.guamlegislature.com/Public_Laws_35th/P.L.%20No.%2035-118.pdf.

[7] *Visualize It: See FAA UAS Data on a Map,* FED. AVIATION ADMIN., https://www.arcgis.com/apps/webappviewer/index.html?id=9c2e4406710048e19806ebf6a06754ad.

[8] Nick Delgado, *FAA, Military Speak to Legal Use of Drones*, GUAM DAILY POST, (Aug. 16, 2021), https://www.postguam.com/news/local/faa-military-speak-to-legal-use-of-drones/article_309c296a-fa76-11eb-82eb-9b4c0ecab6c3.html.

not aware that they need to register their drones prior to flying.[9] The FAA has recorded 869,472 registered drones as of June 13, 2023, with more than half of them being used for recreational purposes.[10] The flight agency has conferred 331,573 Remote Pilot Certificates as of that date.[11]

A heavily regulated airspace presents a unique challenge for Guam's drone community, and further presses the need for trained, licensed drone pilots who are knowledgeable about these federal regulations. To address this demand, the University of Guam (UOG) developed and launched the Drone Corps program.

II. ABOUT THE PROGRAM

A. Program Description & Goals

Fig. 1.1. UOG Drone Corps 2021 cohort students – (left to right) Thor H., Queensly D., Ulysses S., Maria Seanna M., Tristan Q., Brian S., Ferenczi C., and Sean G. – visit the hangar facility near Tech Center Guam during a Part 107b Preparatory Knowledge Course session. (Photo Courtesy: Maria Seanna M.)

The expected increase of drone technology usage in Guam in both educational and commercial sectors led to the launch of the UOG Drone Corps Program in April 2021. The program is a

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[9] Id.

[10] *FAA by the Numbers*, FED. AVIATION ADMIN., https://www.faa.gov/node/26 (last visited Aug. 22, 2023).

[11] *Id.*

collaborative effort between NASA Guam Space Grant (NGSG) and NASA Guam Established Program to Stimulate Competitive Research (EPSCoR) to build technical capacity by creating a cadre of informed, responsible, and FAA-licensed pilots to meet current and future demands for the rising industry. Drone Corps is the university's first drone certification and training program for undergraduate and graduate students. In addition to teaching members the regulations and safety protocols of proper flying operations through the FAA Part 107b examination preparatory knowledge course, the program also provides members with stipends and hands-on experience by flying UAVs through Guam's skies both virtually and physically. Drone Corps aims to preemptively avoid drone accidents, minimize potential conflicts, and increase education and awareness of drone technology through responsible use.

After students are recruited, certified, and trained, they must fulfill 40 hours of flight time through missions, providing aid to: UOG researchers with projects that may be augmented with drone-acquired imagery; local government agencies monitoring restoration sites or conducting site inspections; or nonprofit organizations for other uses. These highly sought-after skills will not only enable student pilots to give these agencies valuable contributions in a variety of applications but will also strengthen relationships between UOG and the local agencies. Through various internship opportunities funded by NASA Guam Space Grant, UOG Drone Corps also prepares its members to enter the work force and incorporate drone technology in various sectors of the economy, including areas such as remote sensing, construction, delivery services, environmental mapping, infrastructure inspection, and emergency services.

B. Capacity & Resources

Fig. 1.2. UOG Drone Corps 2022 Cohort students – (left to right) Jin Hee C., Francisco C., and Javier G. – prepare for a flight mission at Gov. Joseph Flores Memorial Park in Tumon.

The UOG Drone Corps program has administered two cohorts so far. Its inaugural cohort was in 2021 and its second cohort was in 2022. The first year of the program met several challenges, leading to some important lessons to keep in mind for future cohorts and funding cycles. Guam's COVID-19 public health guidance and UOG's corresponding protocols required minimum face-to-face instruction, social distancing of six feet, and limited gathering sizes. In addition to the adjustments for a course being conducted during the COVID-19 pandemic, these restrictions made providing direct instruction to a drone pilot particularly challenging. The easing of the pandemic-related restrictions during the 2022 cohort allowed for a more structured program, such as a practicum portion to allow for more hands-on flight time. Furthermore, UOG currently does not have a flight simulator, which is prohibitively expensive to purchase, or enough entry-level drones for each participant. Partnering with two trusted local UAS companies that have these resources, Aviation Concepts LLC (DBA Tech Center Guam) for its first cohort and Bella Wings Aviation for its second cohort, helped overcome these barriers.

Through funding from NASA Guam Space Grant and NASA Guam EPSCoR, the Drone Corps program accommodated up to 30 students for its first year and 14 students for its second year, including stipends and learning materials. As many as ten entry-level drones were readily available for students to practice with. The program commenced in the spring semester of 2021 and continued through the spring semester of 2022. A third cohort began in the summer semester of 2023.

Fig. 1.3. UOG Drone Corps 2022 cohort students pose for a group photo alongside Bella Wings Aviation instructors during their first day of the Part 107b knowledge course.

The program's workflow is flexible and accommodates students to progress at their own pace. For the 2021 cohort, students participated in the knowledge course in one of three ways: checking into a live stream, watching a recording of the live stream, or attending the class in-person while complying with COVID-19 safety protocols. Students in the 2022 cohort attended an in-person course. Students had access to flight simulator training and access after the knowledge course, for which they had to schedule appointments online. For the 2021 cohort, Tech Center Guam President Art Dawley helped prepare the students for the FAA examination over a three-week period. Dawley was the sole instructor and had some technical assistance from staff from Tech Center Guam, NASA Guam Space Grant, and NASA Guam EPSCoR. For the 2022 cohort, the course with Bella Wings Aviation was divided into two portions: a ground school session that focused on rules and regulations, and a practicum session that provided hands-on opportunities to operate drones.

> ...[T]here was a high level of enthusiasm for understanding government regulations for commercial drone operations given the fact that a greater level of confidence about operating a drone in complex airspace, as well as a greater understanding of how drones can be affected by weather, operational limitations, aerodynamic effects, and various flight configurations, can contribute to a successful outcome of each flight operation. Our initial knowledge test preparation course for the FAA Part 107b Remote Pilot license that we conducted for UOG Drone Corps was very well attended and … those students that I am aware of that took the test scored very highly. Each now possesses an FAA Remote Pilot license that allows them to legally conduct commercial flights in the National Airspace System and pursue further career opportunities.
>
> —Art Dawley

Further instructional time, especially in the mentorship and practical application of drone flight, depends on the student's aptitude and the partner agency with whom the student will perform missions and obtain the requisite 40-hour drone flight experience.

The administrative side primarily consisted of four members: the Associate Director (Dr. Romina King) and Communications Coordinator (Keanno Fausto) of NGSG; and the Executive Director (Dr. Leslie Aquino) and Communications Coordinator (John I. Borja) of NASA Guam EPSCoR.

C. NASA Guam EPSCoR

While NASA is widely known for its research and achievements related to outer space, the national agency also studies Earth and ocean sciences in an effort to better understand the planet's natural systems and the human-induced impacts that affect the global environment.

EPSCoR creates partnerships with local governments, institutes of higher education, and industries that are designed to affect lasting improvements in a state or region's infrastructure, research, and development capacity. NASA EPSCoR supports the NASA Earth and Ocean Science Mission at a local level, with research addressing critical challenges such as coral reef conservation, terrestrial land change, water security, and biodiversity in the Pacific Islands. The NASA EPSCoR program focuses on jurisdictions that have not participated equitably in competitive aerospace and aerospace-related research activities.

NASA Guam EPSCoR's mission is to increase Guam's research capacity and competitiveness in areas relevant to NASA missions and to the Marianas region. The program's objectives are to conduct research that is both relevant to the region and aligned with NASA mission directorates: promote education and workforce development with a focus on geographic information systems and remote sensing applications, promote research and capacity building efforts by UOG faculty through seed grant funding, and foster collaboration between Guam and NASA researchers. NASA Guam EPSCoR is housed within the University of Guam and is currently led by Executive Director Dr. Leslie Camacho Aquino.

> Drone Corps will be a fantastic supplement to the NASA Guam EPSCoR Program. We see Drone Corps as directly building research capacity at UOG by allowing researchers to incorporate drone-acquired imagery into their projects, when they might not have done so otherwise due to lack of expertise or an experienced drone operator.
>
> —Dr. Leslie Camacho Aquino

D. NASA Guam Space Grant

The UOG Drone Corps program is partially funded by NGSG, an affiliate of the University of Hawai'i Space Grant Consortium (HSGC). In 2019, NASA allocated funds to specifically benefit the United States territories as part of the National Space Grant College and Fellowship Program. UOG was awarded the full amount of $750,000, at $150,000 per year, via a subaward from HSGC in

April 2020.[12] It is through this subaward that NGSG financially supports the UOG Drone Corps project's various components, including the costs of the knowledge course and the three monetary stipends that serve as incentives for members as they complete their flight hours.

Through UOG Drone Corps, NGSG aims to support its goal of training future generations of professionals in STEM fields concerned with the understanding, utilization, exploration, and investigation of both Earth and space – including the local island environments of Guam and Micronesia. Among its primary programs, NGSG manages the NGSG University Research Internship and Fellowship, which awards undergraduate and graduate students at UOG with Space Grant funding to allow them to pursue research projects relevant to NASA's goals.[13] One particular internship, the NASA Guam Space Grant Professional Internship program, pairs students with industry mentors from local agencies and companies to gain workplace experience. UOG Drone Corps is aligned with NASA Guam Space Grant's role in spearheading interdisciplinary careers in STEM, inspiring students to pursue careers in fields that will continue to heavily rely on the incorporation of drone technology as the respective industries advance into the future.

III. PROGRAM TIMELINE

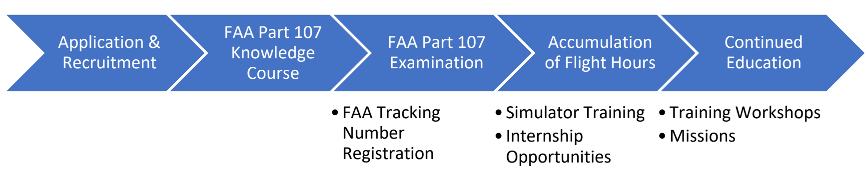

Fig. 2.1 Workflow timeline of the UOG Drone Corps program.

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[12] *NASA Guam Space Grant Program*, UNIV. OF GUAM, https://www.uog.edu/nasa-guam-space-grant/information.php (last visited June 23, 2023).

[13] *Undergraduate Students: Become a NASA Guam Space Grant Intern!*, UNIV. OF GUAM, (Oct. 19, 2021), https://www.uog.edu/news-announcements/2021-2022/2021-undergraduate-students-become-a-nasa-guam-space-grant-intern.php.

The UOG Drone Corps program was designed to be completed within one full academic year, granting students a flexible period in which they can meet the demands of the program while maintaining their schoolwork and other extracurricular activities. Students can opt to remain in the program past their initial year to serve as mentors to new cohorts, continue to fly, and organize future missions. Beyond the application process, the program spans three primary sections: the completion of the FAA Part 107b examination knowledge course, the FAA Part 107b certification, and the accumulation of flight hours. The program is augmented by workshops that are specific to equipment that would be used. For example, Drones Optics, a local private firm, organized a workshop entitled "Best practices for the maintenance and operation of the Phantom Pro 4, RTK," allowing students to learn about the device and its payload. At the end of each milestone, a student is entitled to receive three monetary stipends. The stipends totaled $675 for the first cohort and $2000 for the second cohort.

A. Applications & Eligibility

The UOG Drone Corps program was officially announced in April 2021 through various communication outlets, including the university website,[14] internal newsletters, mass emails, local newspaper publications,[15] social media channels, and news broadcasts. To be eligible, an applicant was required to be a U.S. citizen, a UOG student, and at least eighteen years of age. The eligibility criteria were expanded for the 2022 cohort to include students attending Guam Community College. Applicants were also required to be in good academic standing, maintaining a cumulative grade point average of 2.5 or higher. No prior experience with drone flying or operational knowledge was required. Among 38 applicants, 27 students were formally accepted into the program's inaugural cohort. The program's second cohort accepted 14 students.

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[14] *UOG Launches Drone Corps Program*, UNIV. OF GUAM, (Apr. 15, 2021), https://www.uog.edu/news-announcements/2020-2021/uog-launches-drone-corps-program.php.

[15] *UOG Offers Drone Training Program*, GUAM DAILY POST, (Apr. 16, 2021), https://www.postguam.com/business/local/uog-offers-drone-training-program/article_5622513a-9d9e-11eb-9830-9b2b2e03ab93.html.

B. Knowledge Course

Fig. 2.2 UOG Drone Corps students Jeremy D. and Alexis E. hold their study materials during the Part 107b Preparatory Knowledge Course.

Upon acceptance into the UOG Drone Corps program, students participated in a three-week knowledge course that focused on preparing them to pass the FAA Part 107b Remote Pilot written examination.[16] To provide training and resources, UOG Drone Corps built partnerships with two privately-owned drone companies. The first cohort's knowledge course was administered by Tech Center Guam while the second cohort's course was instructed by Bella Wings Aviation. Both organizations are local privately-owned UAS training facilities that offer instructor-led teaching, practice test guides and a virtual flight simulator.[17] The course centered around the ASA Remote Pilot Test Guide, with the curriculum itself spanning various drone-related topics, including regulations, weather systems, loading, performance, and operations. Topics on drone flight regulations included acceptable flight times and

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[16] *Students Takes the First Steps to Become Certified Drone Pilots*, UNIV. OF GUAM, (Aug. 6, 2021), https://www.uog.edu/news-announcements/2020-2021/2021-Students-take-first-steps-to-become.php.

[17] *UAS Organizational Training*, TECH CENTER GUAM, https://www.techcenter-guam.com/ (last visited Aug. 22, 2023).

locations, qualifications for drone operators, and local airspace boundaries.

The first cohort's knowledge course was held onsite at Tech Center Guam's classroom and hangar facility located at the A.B. Won Pat International Airport. To accommodate those who were unable to attend physically, members were given the option to either attend online via Zoom or view the recorded sessions during a more convenient time. Some students chose to attend the classes through a hybrid model, which consisted of onsite and live stream attendance. Due to the easing of COVID-19 related restrictions in 2022, the second cohort's knowledge course was only held onsite at Bella Wings Aviation's facility located at Tumon Sands Plaza. Students from this cohort were also able to participate in a practicum portion that gave them hands-on time with drones to practice basic maneuvers and operations. Members who completed the knowledge course could claim their first monetary stipend, worth $175 for the 2021 cohort and $500 for the 2022 cohort. Most students used this stipend to pay for the cost of the FAA examination.

C. FAA Part 107b Examination

Fig. 2.3 UOG Drone Corps members Jonelle S., Maria Seanna M., and Ulysses S. hold up their Part 107 licenses during a Drone Flight Safety PSA video.

At the end of the three-week preparatory course, students registered for their FAA tracking number (FTN), a career-long identification code needed prior to taking the remote pilot examination. The registration process was completed via the Integrated Airman Certification and Rating Application (IACRA), a web-based rating program that guides applicants through the certification process and ensures that they meet regulatory and policy requirements.[18] Once students had their FTN codes registered, they had a flexible period during which they could schedule their FAA Part 107b written test. Examinations were proctored and held at Trend Vector Aviation, an aviation and certification facility in Guam.[19] As of November 2022, twenty-four total UOG Drone Corps members from both cohorts successfully passed their FAA Part 107b exam and received their Part 107b licenses. This remote pilot certification is valid for two years. Students must score 70% at minimum to pass

[18] *Integrated Airman Certification and Rating Application (IACRA)*, FED. AVIATION ADMIN., https://iacra.faa.gov/IACRA/Default.aspx (last visited June 23, 2023).

[19] *About TVA*, TREND VECTOR AVIATION INT'L, http://www.trendvector.com/tvaie/office_e.htm (last visited June 23, 2023).

the Part 107b examination.[20] Members who received their certification were able to claim their second monetary stipend, worth $200 for the 2021 cohort and $500 for the 2022 cohort.

D. Flight Hours

As part of the UOG Drone Corps program, both certified and non-certified members had access to opportunities in order to accumulate the required target goal of 40 flight hours. The three primary ways for UOG Drone Corps members to gain flight hours are through simulator training, internships, and missions.[21] Flight hours are recorded in a flight logbook (see Appendix B), which is based on the Standard UAS Log and has been updated to comply with the new sUAS regulation 14 CFR Part 107b as stipulated by remote pilot certificate requirements.

Fig. 2.4. Tech Center Guam President and Instructor Art Dawley guides UOG Drone Corps students, Thor H., Ulysses S., and Queensly D., through a drone simulator training.

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[20] *What Drone Pilots Need to Know About the Part 107 Exam*, DRONESENSE: DRONESENSE BLOG (Aug. 11, 2016), https://blog.dronesense.com/what-drone-pilots-need-to-know-about-the-part-107-exam.

[21] NASA Guam Space Grant financed additional hours of flight simulator time so students could practice based on their availability.

The simulator training offered members who had not yet received their remote pilot certification the chance to practice enterprise flight scenarios and sharpen their skills in a virtual environment. Each practice session, which used either the DJI Enterprise Simulator or the NIST Simulator, focused on granting students the ability to learn basic and advanced flight maneuvers using camera and video systems.

For members who received their certification, the program offered internships and mission opportunities that required the physical operation of drones. Through the NASA Guam Space Grant Professional Internship program, for example, Drone Corps students were paired with industry mentors from private drone companies to offer their remote pilot skills. These hands-on opportunities allowed students to gain flying experience and specialized skills by assisting select local agencies, including the university's own research units, in capturing drone footage and data for their research projects. One opportunity offered to members was an internship with Tech Center Guam, where interns not only practiced operating drones, but also developed drone-training curriculums for agencies, such as the Guam Fire Department.[22] Other mission opportunities offered to students included a partnership with the Guam Department of Agriculture, where students would operate their drones to survey erosion-prone areas and identify ideal spaces for reforestation. Upon completion of their 40 flight hours, members were able to claim their final monetary stipend, worth $300 for the 2021 cohort and $1000 for the 2022 cohort.

E. Continued Education

Newly licensed students with 40 hours of flight time can receive more training through workshops. These workshops focus on best practices of mission planning, flight preparation, flight operation, education of various sensors, contingency planning, data acquisition, data processing, and equipment maintenance. NASA Guam Space Grant and NASA Guam EPSCoR are jointly operating a geographic information system and remote sensing (GIS/RS)

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[22] Steve Limtiaco, *Money for Drones: GEDA Announces Latest Winners of QC Grants*, PAC. DAILY NEWS (May 20, 2021), https://www.guampdn.com/news/local/money-for-drones-geda-announces-latest-winners-of-qc-grants/article_59d07b33-ccaa-5c37-8282-1d0ba817fcc2.html.

laboratory named the Micronesian Area Geospatial Information Center (MAGIC). The MAGIC lab will provide a base of operations for Drone Corps. Pilots will be able to view and sign up for mission requests from UOG units, Government of Guam agencies, and non-profit agencies.

F. Outreach

In its mission to not only create more licensed remote pilots for the region, but to create responsible ones, the UOG Drone Corps has also conducted various outreaches. Members have participated in various expos and fairs in order to educate diverse sectors of the community about proper drone usage on the island. During an expo catered toward contractors and homeowners in September 2022, for example, members ran a booth where they explained to attendees how drones can be used to make construction projects more efficient through aerial mapping and LiDAR scanning. In an additional outreach that focused on STEM opportunities for the island's youth, Drone Corps members hosted a drone simulator station for visitors to try out. Members addressed common misconceptions about drones, emphasizing that drones are tools and not toys. A common goal of these outreaches was to educate the public that there are numerous opportunities for individuals of all backgrounds to get engaged with the drone industry.

IV. TESTIMONIALS

The following testimonials are written by the president of Tech Center Guam and two UOG Drone Corps members from the 2021 cohort who interned with Tech Center Guam. These testimonials detail these individuals' background and experience with the program and internship, as well as their beliefs on the future of the drone industry in Guam.

A. Art Dawley

Tech Center Guam was established three years ago with the focus of creating commercial opportunity and career paths for students interested in the unmanned aircraft and robotics sector. Our paid internship program with UOG Drone Corps has created exactly this opportunity. We currently utilize Drone Corps students as trainers and assessors in our public safety agency training and assessment program, which is sponsored by the U.S. Department of Commerce. Drone Corps students will also be utilized as program manager trainees for a recently awarded Guam government drone program, which focuses on operational implementation of drone programs for various public agencies here on the island.

I think there is a lot of perfectly legitimate concern in local communities that drones are not necessarily used for commercial good and infringe on privacy rights of citizens. Additionally, there is also the perception that drones can be quite easily purchased by unskilled, untrained, and unknowledgeable operators with little regard to local or federal regulations, which is also understandable. It is important for the local community to understand that drones can have a significant positive impact on our everyday lives by providing, among other things, rapid response assistance in natural or local disasters, assistance to public safety agencies in search and rescue, fire or law enforcement operations, critical supply delivery, monitoring of our environment, and many other activities that benefit the community. Because drones are classified as "aircraft" by the FAA and they share the National Airspace System with crewed aircraft (commercial airliners and private aircraft), they also need to share in the same responsibilities for safe operating practices that minimize risk and adhere to local and federal regulations regarding privacy. This is achieved by requiring drone pilots operating for commercial purposes to have an FAA Remote Pilot license and also register their drones in a federal database. It should be noted that the vast number of complaints regarding unsafe operation or invasion of privacy result from non-licensed operators not engaged in commercial activity. For now, the FAA does not require a Remote Pilot license for non-commercial operators. However, they are required to adhere to similar guidelines and regulations as commercial operators.

B. Maria Seanna Minas

My name is Maria Seanna Minas, and I graduated from the University of Guam (UOG) in Spring 2020 with a major in Mathematics. I was born in Guam and currently reside in the village of Dededo with my parents. Since I have lived on Guam my whole life, I have been exposed to this "paradise" many visitors desire to experience. Although many people admire Guam for its beaches, foods, and other tourist attractions, I have admired the gradual development of technology on the island, whether it would be in schools, public facilities, or workplaces. This has inspired me to pursue a degree in STEM. STEM focuses on the disciplinary principles of science, technology, engineering, and mathematics. With these principles, students are provided the skills and experiences to promote STEM in the community – to contribute to a technological society. Hence, my degree in Mathematics serves a purpose to educate younger generations about STEM and inspire them to discover ways to advance the community in all aspects of technology.

To spearhead my career in STEM, I decided to apply for the UOG Drone Corps Program. I first heard about this program through a STEM professor at UOG. She informed me that as the use of drones continues to rise in both education and commercial sectors, UOG's first-ever certification and training program will expose students to unique research opportunities involving capturing drone footage and data for local agencies. My motivation for applying for the UOG Drone Corps was to discover new personal interests in the drone industry and to build up my background experience in conducting research. From watching aerial footage on commercials and on social media, I have gained an interest in becoming a drone pilot. This program indeed has offered me the opportunity to safely fly unmanned aerial vehicles while capturing footage and data for academic missions. Given this opportunity, I became more eager to learn about drones, such as understanding the integration of technology and programming in several research projects. While in this program, I can acquire more knowledge about drones, gain more research experience, establish and improve relationships, and lastly, develop a background in flight projects and experiences.

Fig. 3.1. UOG Drone Corps member, Maria Seanna Minas, earns flight hours flying drones during her internship with Tech Center Guam.

However, my experience with the Drone Corps did not end after the three-week course. Through UOG Drone Corps, I was able to extend my drone experience under Tech Center Guam, a subsidiary of Aviation Concepts, as one of their project interns, along with Thor Hauerbach. After acquiring a Temporary Airman Certificate, we were able to apply our knowledge of the Federal Aviation Administration's (FAA) Part 107b materials and regulations to our virtual and in-field training. Under the mentorship of Mr. Art Dawley, a former Certified Flight Instructor (CFI) and private pilot, we have completed the following certifications in preparation for our current project of public safety: National Fire Protection Association (NFPA) and National Institute of Standards and Technology (NIST) for Measuring Capabilities and Remote Pilot Proficiency (Course Number ALC-716). Tech Center Guam was contracted to train and guide the Guam Fire Department in attaining an FAA Part 107b Remote Pilot License through our designed curriculum using the NIST training guidelines.

Throughout my experience with both UOG Drone Corps and my internship at Tech Center Guam, I can continue to immerse myself in various flight conditions and environments to best assess my proficiency as a new drone pilot. Prior to these programs and projects, I had no general drone experience with small unmanned aircraft systems (sUAS). I often saw people fly drones in public parks, but I did not think flying one required a remote pilot license, waivers, or authorizations (if applicable) and mobile applications. With the help of Tech Center Guam, I have been granted access to fly both the simulator and the actual drones: Phantom 4 Pro V2 and Mavic Pro. I have only flown a drone under the supervision of Mr. Art Dawley during our in-field training. One obstacle I faced during the process was having to overcome my nervousness in flying a drone alone. Flying a company drone comes with great responsibility. Although I have passed several certifications that qualify me to fly, I need more practice and in-field guidance when it comes to unlocking airspace under temporary flight restrictions.

As Guam continues to integrate technology in many workplaces, the country's current efforts in using drone flights and displays for entertainment has sparked this year. Guam hosted its first drone light show at Ypao Beach in celebration of Liberation Day. Although this display has attracted many locals, I believe the involvement of drones in many workplaces and schools will contribute to the advancements in technologies on the island. As schools continue to improve their curriculum, we can encourage the Department of Education to implement a drone simulation course in which students can learn to program drones before flying one (quite similar to the robotics courses offered now). In workplaces, many drones have been used to survey lands, as well as capture drone footage and data for local agencies. With our current project involving public safety, the use of drone technology will be an asset to search and rescue by improving situational awareness, helping locate missing people or suspects, combating fires and inspecting damage or accidents. The future of drones may depend on the future students' interest in aviation and in the STEM field. Introducing them to aviation concepts at early ages will spark a great interest in developing improvements in our community through the use of advanced technology.

C. Thor Hauerbach

My name is Thor Hauerbach. I am a student at the University of Guam (UOG) majoring in Business Administration. Currently, I reside in the village of Sinajana with my family, where I have lived for the past year and a half. Prior to moving to Guam, I attended community college in Los Angeles, California, where I was born and raised. The decision to move to Guam was greatly influenced by the opportunity to explore a new environment while also being able to progress academically and experience the so-called "island life," a lifestyle that seems only to get better with the time I spend here. Following graduation, I intend to move back home to California and go to law school.

I first heard about the UOG Drone Corps Program through an email sent to students in April of 2021. The email invited interested students to apply for this great opportunity. Without hesitation, I applied for the program. I knew I would stop at nothing in order to become a part of it. For as long as I can remember, I have had a passion for airplanes and the realm of aviation. This alone is my major reason for applying and having interest in the program. Following the submission of my application, I anxiously awaited the outcome. Eventually, I received an email in June of the same year, notifying me that I had been accepted into the program. I was ecstatic and could not wait to learn and dive head-first into the experiences and opportunities that lay ahead. One month later, we began the Knowledge Course segment of the UOG Drone Corps Program. For three weeks, a cohort of students and I learned the ins and outs of the Federal Aviation Administration's Part 107b materials and regulations, taught by Mr. Art Dawley (my current supervisor), a former Certified Flight Instructor (CFI) and private pilot. At the end of the knowledge portion of the program, we were encouraged to take the FAA Part 107b exam. I did so immediately and passed with a score of 94%.

Fig. 3.2. UOG Drone Corps member, Thor Hauerbach, earns flight hours flying drones during his internship with Tech Center Guam.

Following the conclusion of the knowledge portion of the program and passing the FAA Part 107b exam, the UOG Drone Corps students were invited to apply for an internship at Tech Center Guam, a subsidiary of Aviation Concepts. Mr. Dawley is also the president of Aviation Concepts/Tech Center Guam, and directly supervises me and one other intern, Maria Seanna Minas. Maria and I came onboard as interns for Tech Center Guam in September. In the time that we have worked for Mr. Dawley, we have completed certifications for the National Fire Protection Association (NFPA), as well as for the National Institute of Standards and Technology (NIST) for Measuring Capabilities and Remote Pilot Proficiency (Course Number ALC-716). Additionally, I have been tasked with the development of a curriculum to implement using NIST guidelines in order to facilitate training for the Guam Fire Department (GFD), with whom Tech Center Guam was awarded a contract to train and guide in attaining the FAA Part 107b Remote Pilot License.

Prior to joining the UOG Drone Corps Program, I had no experience or familiarity with small unmanned aircraft systems (sUAS), although I did have some past experience with remote controlled aircraft. In the past months, I have spent numerous hours on the

DJI Enterprise simulator, both doing skill training exercises and free flight, and have also had the privilege to fly real drones like the DJI Mavic Pro and Phantom 4 in the field. After some time flying in the field with Mr. Dawley, he entrusted me to bring home the company Mavic Pro for a weekend. Before flying by myself, I was always with Mr. Dawley. I felt as if he was a licensed driver and I was a beginner driver. I drove around Guam that weekend and flew at a handful of places. I got over my initial anxiety and had a great, joy-filled experience.

Guam does not celebrate the 4th of July with nearly as much energy and enthusiasm as it celebrates Liberation Day on July 21st. Liberation Day commemorates the United States' second invasion of Guam, which ended the Japanese occupation in 1944. Each year, families, friends, and strangers gather at popular areas to witness displays of fireworks, performers, and parades. This most recent year, although there was no parade, there was a drone show conducted over Tumon Bay, followed by fireworks from two beaches. The drone show used over 100 drones, all modified with lighting accessories, synchronized via computer software to project images in the star-filled sky. The crowd was in awe of the various images and messages presented. The drone show of 2021 Liberation Day was a hallmark event in terms of drone performances. I am certain that there will be more to come soon.

In the near future, I hope to see more integration of sUAS by various Government of Guam agencies, especially by agencies directly involved in public safety. While the training facilitated by Tech Center Guam is a remarkable start, it is clear that many other agencies have a use for drones in regard to doing their respective jobs. For example, the Department of Agriculture can use similar training to inspect potential farmland and wildlife habitats.

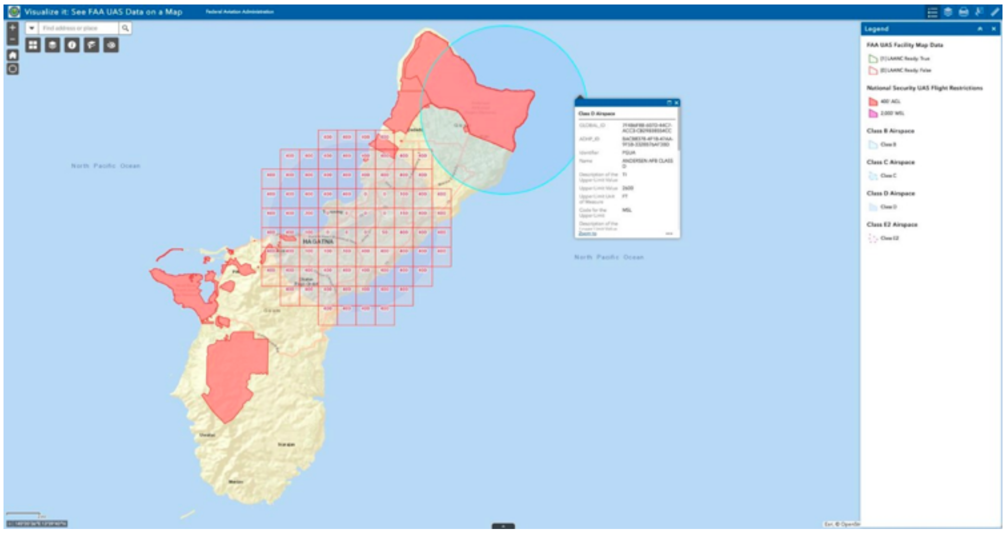
V. LIMITATIONS

Despite the UOG Drone Corps program seeing several successes during its first year, including the certification of 12 members as remote pilots, several limitations of the program can be identified and improved upon in future cohorts. The first limitation of the study was that the program was launched during the ongoing COVID-19 pandemic, resulting in ever-shifting schedules and facility closures. While many of the issues brought on by the pandemic are beyond the control of the program, planning for future cohorts should include continuity measures that would mitigate disrupted program operations. A related limitation was that several accommodations were made to account for pandemic-related circumstances, including a reliance on the virtual environment and the option for students to participate in the program asynchronously (e.g., flexible deadlines and hybrid participation). Since drone training is a rigorous and immersive practice heavily dependent on hands-on guidance, future cohorts should consider ways to ensure that students are guided and kept engaged with the material throughout the course. These pandemic-related restrictions proved to be less of an obstacle during the program's 2022 cohort. Finally, as stipulated by NGSG funds, the program was only made available to UOG and GCC students who are U.S. citizens. To provide a more diverse and inclusive experience for all, future iterations of the program should consider finding ways to offer the UOG Drone Corps program to Guam residents of all backgrounds.

VI. CONCLUSION

As drones become increasingly accessible and inexpensive to purchase both globally and locally, it is expected that the adoption of drones by students, private individuals, businesses, and public authorities on Guam will increase tremendously in the coming years. To meet this demand, the UOG Drone Corps program plans to expand its program in several ways for future cohorts. This includes broadening the range of partnerships with whom students are able to work when accumulating their flight hours, including local organizations that will inevitably emerge because of accelerated drone use. Specific industries that the program aims to collaborate with include those who deal with areas such as crop monitoring, cargo transport, safety and surveillance, and storm tracking. Given the expectation that drones will continue to extend to a diverse range of areas beyond the academic field, the UOG Drone Corps program also aims to integrate lessons into its curriculum that specifically focus on the recreational uses of drones, such as aerial cinematography and photography. As drone technology continues to advance and becomes safer as a result, the curriculum should also consider any changes made to the currently restrictive FAA regulations.

APPENDIX A



Appendix A. This map highlights the current airspace restrictions on Guam as regulated by the Federal Aviation Administration.[23]

[23] *Airspace Restrictions*, FED. AVIATION ADMIN., https://www.faa.gov/uas/recreational_fliers/where_can_i_fly/airspace_restrictions/ (last updated June 14, 2022).

APPENDIX B

UOG DRONE CORPS FLIGHT LOG

UNIVERSITY OF GUAM
UNIBETSEDÅT GUÅHAN

NAME ______________________
MAILING ADDRESS ______________________
____

LOGBOOK NUMBER ______________________
FROM ______________________
TO ______________________

Certificates Held

Type	Date Issued	Certificate Number
Remote Pilot	________	________
Student Pilot	________	________
Sport Pilot	________	________

Knowledge Exam Completed (Date) ______________________

Rating Record

- ☐ Unmanned (UAS)
- ☐ Small UAS

Recurrency Training Completed

____
____
____

Year 20__ DATE	UAS MAKE & MODEL	AIRCRAFT IDENT. COA #/DATE	FROM	TO	TYPES OF OPERATING TIME			Flight Time	TOTAL DURATION OF FLIGHT *(0.1 ≈ 6 mins.)*	REMARKS, MISSION, CREW, EXEMPTION NUMBER	Advisor Signature
					REMOTE PIC	MISSION COORDINATOR	INSTRUCTOR				

The UOG Drone Corps Flight Log is based on The Standard Unmanned Aircraft Systems (UAS) Log, which has been updated to comply with the new small unmanned aircraft systems regulation, 14 CFR part 107, Remote Pilot certificate requirements. This log does not contain requirements for private pilots, commercial pilots, and flight instructors.

Appendix B. A copy of the UOG Drone Corps Flight Log used by members to log their flight hours.