USING DRONES TO REDUCE THE RISK OF LITIGATION IN THE CONSTRUCTION, ENERGY, AND AGRICULTURE INDUSTRIES

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ABSTRACT

"An invention has to make sense in the world it finishes in, not in the world it started."
– Tim O'Reilly

An unmanned balloon full of explosives would prove to be the first drone, or unmanned aerial vehicle ("UAV"), ever created.[1] Military forces across the globe then developed and implemented UAVs to take photographs, distract enemy forces, and assist troops in battle. From pilotless airplanes that carried bombs during WWI and WWII[2] to the *Lockheed Martin RQ-170 Sentinel* that located Osama bin Laden,[3] the United States military has developed, advanced, and implemented life-changing UAV technology. After the government sector demonstrated successful UAV capabilities, commercialization of UAVs became popular.

This article first discusses the history of drones, from militarization to commercialization. It next discusses current commercial UAV usage in the United States, including package deliveries, sports broadcasting, marketing, and wildfire fighting. Thereafter, this article sets forth the various components that comprise the typical UAV, such as the flight components, location-aware technology, and cameras. This article next analyzes federal and state UAV laws and discusses the potential for pre-emption issues. Finally, this article discusses the ways in which commercial UAVs can be used to reduce the risk of litigation in the construction, energy, and agriculture industries.

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[1] *The History of Drones (Drone History Timeline from 1849 to 2019)*, DRONENTHUSIAST, https://www.dronethusiast.com/history-of-drones/ (last visited Jul. 2, 2020).

[2] Tuan C. Nguyen, *The History of Drone Warfare*, THOUGHT CO. (Jul. 26, 2019), https://thoughtco.com/history-of-drones-4108018.

[3] *Lockheed Martin RQ-170 Sentinel*, WARRIOR LODGE, https://warriorlodge.com/pages/lockheed-martin-rq-170-sentinel (last visited Jul. 28, 2020).

I. THE HISTORY OF DRONES

Drones, also known as unmanned aerial vehicles ("UAVs"), are used across the world in military, commercial, and recreational settings.[4] The history of UAVs can be traced back to the 19th century, when they were first designed and used for military purposes.[5] Commercial uses of UAVs, however, did not originate until the 21st century.[6]

A. UAVS IN THE 19TH CENTURY

The origin of UAVs is a point of contention amongst experts in the drone community. Some assert that the first UAV originated in Austria in 1849, when Austrian soldiers deployed unmanned balloons full of explosives to attack Venice.[7] Under this theory, a UAV is defined as "any aerial vehicle that is unmanned."[8] Others, however, argue that unmanned balloons were not in fact UAVs, because they were not "a remote-less controlled piloted aircraft or missile."[9]

In 1883, British meteorologist Douglas Archibald took the first aerial photograph using a kite.[10] To do so, Mr. Archibald attached a long string to the shutter release of a camera.[11] Then, during the Spanish-American War of 1898, the United States military used Mr. Archibald's concept when it deployed camera-attached kites to capture surveillance of enemy sites.[12] These photographs were the first aerial military reconnaissance photographs ever taken.[13]

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[4] Kashyap Vyas, *A Brief History of Drones: The Remote Controlled Unmanned Aerial Vehicles (UAVs)*, INTERESTING ENGINEERING (Jun. 29, 2020), https://interestingengineering.com/a-brief-history-of-drones-the-remote-controlled-unmanned-aerial-vehicles-uavs.

[5] *The History of Drones (Drone History Timeline from 1849 to 2019)*, *supra* note 1.

[6] Luke Dormehl, *The History of Drones in 10 Milestones*, DIGITAL TRENDS (Sep. 11, 2018), https://www.digitaltrends.com/cool-tech/history-of-drones/.

[7] Vyas, *supra* note 4.

[8] *The History of Drones (Drone History Timeline from 1849 to 2019)*, *supra* note 1.

[9] *Drone Technology: Invention And Advances*, LEADERSHIP NEWSPAPER (2019), https://leadership.ng/drone-technology-invention-and-advances/.

[10] DOUGLAS ARCHIBALD, THE STORY OF THE EARTH'S ATMOSPHERE 185 (1897).

[11] *Id.*

[12] Nguyen, *supra* note 2.

[13] Ciaran Doyle, *A Short History of Drones*, MEDIUM (Jul. 12, 2018), https://medium.com/soar-earth/a-short-history-of-uavs-3f84e7b7e998.

Later that same year, inventor Nikola Tesla shared his vision for the militarized use of UAVs, which evolved from his experimentation with a remote controlled system that used radio signals to maneuver vehicles.[14] In his 1898 patent entitled *Method of and Apparatus for Controlling Mechanism of Moving Vessels or Vehicles*, Mr. Tesla outlined his vision as follows:

> The invention which I have described will prove useful in many ways. Vessels or vehicles of any suitable kind may be used, as life, dispatch, or pilot boats or the like, or for carrying letters, packages, provisions, instruments, objects, or materials of any description, for establishing communication with inaccessible regions and exploring the conditions existing in the same . . . but the greatest value of my invention will result from its effect upon warfare and armaments, for by reason of its certain and unlimited destructiveness it will tend to bring about and maintain permanent peace among nations.[15]

Shortly after filing his patent, Mr. Tesla provided the world a brief glimpse into how this technology worked.[16] In front of an amazed audience at the annual Electrical Exhibition in New York City, New York, Mr. Tesla delivered a demonstration whereby he used a control box that transmitted radio signals to maneuver a toy boat along a pool of water.[17] Though, today, this idea may seem elementary, in the 19th century, few people knew about the existence of radio waves.[18]

B. UAV USAGE DURING WORLD WAR I & WORLD WAR II

In 1916, using Mr. Tesla's designs, the British developed the first "pilotless" aircraft: *The Ruston Proctor Aerial Target*.[19] This radio-controlled UAV was used as a "flying bomb" to counter German fighter aircraft.[20] *The Ruston Proctor Aerial Target* was the first of its kind, a pilotless, winged aircraft, which inspired similar UAV projects around the world.[21] The next year, the United States Navy collaborated with Elmer Sperry and Peter Hewitt to construct a radio-controlled aircraft that would eventually be used

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[14] Nguyen, *supra* note 2.

[15] U.S. Patent No. 613,809A (filed Jul. 1, 1898) (issued Nov. 8, 1898), https://patentimages.storage.googleapis.com/6b/b5/5d/3dc49d9a2758de/US613809.pdf; *Nikola Tesla U.S. Patent 613,809 – Method of and Apparatus for Controlling Mechanism of Moving Vehicle or Vehicles*, TESLA UNIVERSE, https://teslauniverse.com/nikola-tesla/patents/us-patent-613809-method-and-apparatus-controlling-mechanism-moving-vehicle-or (last visited Jul. 2, 2020).

[16] *Id.*

[17] *Id.*

[18] *See id.*

[19] *The History of Drones (Drone History Timeline from 1849 to 2019)*, *supra* note 1.

[20] *Id.*

[21] Dormehl, *supra* note 6.

as a bomber without a pilot: the *Hewitt-Sperry Automatic Airplane*.[22] This UAV utilized a gyroscope system[23] that stabilized the aircraft, a barometer for altitude control, a radio-controlled wing, and parts that measured distance flow.[24] This combination of components allowed the aircraft to "fly a pre-set course to a target where it would either drop a bomb or simply crash."[25]

Although the *Hewitt-Sperry Automatic Airplane* was technologically advanced for its time, it was flawed in many ways. As a result, in 1918, the United States military brought in Charles Kettering to collaborate with Mr. Sperry and Orville Wright to develop a more advanced UAV.[26] Together, Mr. Kettering, Mr. Sperry, and Mr. Wright developed the *Kettering Bug*, a pilotless airplane designed to carry a bomb to a pre-set target.[27] This UAV used a four-cylinder engine and had a range of up to 75 miles.[28] Many considered the *Kettering Bug* project a success; however, World War I ended before it could be used in combat.[29]

Many years after the end of World War I, radio-controlled UAV technology continued to develop, with the British Royal Navy taking the lead.[30] In fact, the British Royal Navy designed UAVs to mimic the movements of enemy aircraft, and in 1935, it constructed the *DH.82B Queen Bee*,[31] which was a radio-controlled version of its manned aircraft, the *de Havilland Tiger Moth*.[32] The *DH.82B Queen Bee* was a low-cost target aircraft used for "realistic anti-aircraft gunnery training."[33] Between 1933 and 1943, the British Royal Navy built 412 *DH.82B Queen Bee*s, 360 of which were float planes.[34] The term "drone," when referring to a UAV, arose out of the *DH.82B Queen*

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[22] Nguyen, *supra* note 2.

[23] Gyroscopes are sensors that measure or maintain rotational motion, and are used in altitude sensors, compasses, and turn coordinators. Gyroscopes contain a wheel or rotor that rotates at a high rate per minute ("rpm"), which enables it to aid in rigidity and precision. *Gyroscopic Principles*, EXPERIMENTAL AIRCRAFT INFO, https://www.experimentalaircraft.info/articles/aircraft-gyroscopic-principles.php (last visited Jul. 2, 2020).

[24] Nguyen, *supra* note 2.

[25] *Id.*

[26] *Id.*

[27] *Id.*

[28] Doyle, *supra* note 13.

[29] *The History of Drones (Drone History Timeline from 1849 to 2019)*, *supra* note 1.

[30] Nguyen, *supra* note 2.

[31] *Id.*

[32] *See De Havilland Tiger Moth & Queen Bee*, BAE SYSTEMS, https://www.baesystems.com/en/heritage/de-havilland-tiger-moth—-queen-bee (last visited Jul. 2, 2020). The British *de Havilland Tiger Moth* was a manned aircraft used for training purposes only. Although the *DH.82B Queen Bee* was designed to look like the *de Havilland Tiger Moth*, it was controlled using UAV technology.

[33] *De Havilland DH82B Queen Bee*, DE HAVILLAND AIRCRAFT MUSEUM, https://www.dehavillandmuseum.co.uk/aircraft/de-havilland-dh82b-queen-bee/ (last visited Jul. 2, 2020).

[34] *Id.*; *see Floatplanes History*, SCHWEISS, https://www.bifold.com/floatplanes-history.php (last visited Jul. 2, 2020) (A float plane is an aircraft that utilizes pontoons instead of wheels which enables the aircraft to take off and land on water.).

Bee project.[35] Thereafter, in 1937, using a similar design and similar technology, the United States Navy developed the *Curtiss N2C-2 Drone*.[36] Like the *DH.82B Queen Bee*, the United States Navy used the *Curtiss N2C-2 Drone* as target practice for anti-aircraft gunmen.[37] However, it was "remotely controlled from another aircraft, which made the design revolutionary."[38]

During World War II, Reginald Denny emigrated from Great Britain to the United States, where he founded Radioplane Company, the first mass-producer of drones.[39] Mr. Denny then developed the remote-controlled *Radioplane OQ-2*, which was used by the United States military as a target for anti-aircraft training.[40] With a simple design, it comprised a two-cylinder, two-cycle piston engine, produced up to 22 horsepower, powered two contra-rotating propellers, and was launched by catapult and landed by parachute.[41]

Like the United States, Nazi Germany reintroduced drones in combat operations during the later portion of World War II.[42] In fact, Nazi Germany developed the *V-1 rocket* (aka *The Buzz Bomb*), which contained new technology that improved drone accuracy and the degree to which drones caused damage.[43] The *V-1 rocket* utilized a gyroscopic system, carried a 2,000-pound warhead, and could travel up to 150 miles away from the person controlling it.[44] Once it was over its intended target, the *V-1 rocket's* sophisticated guidance system put it into a nose dive.[45] The Nazis used this technology against civilian targets, which led to approximately 10,000 deaths and 28,000 injuries.[46]

On the other side of World War II, the Japanese used hydrogen-filled balloon-drones to carry small bombs to the United States.[47] These balloon-drones were 30-feet in diameter, had payloads of approximately 32 paper sandbags, and used altitude regulation mechanisms to travel to the United

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[35] Vyas, *supra* note 4.

[36] *Id.*

[37] Nikola Budanovic, *The Early Days of Drones – Unmanned Aircraft from World War One and World War Two*, WAR HIST. ONLINE (Jul. 23, 2017), https://www.warhistoryonline.com/military-vehicle-news/short-history-drones-part-1-m.html.

[38] *Id.*

[39] Nguyen, *supra* note 2 (explaining that roughly 15,000 *Radioplane OQ*-2 drones were manufactured for the United States military).

[40] *See id.*

[41] Tom Fey, *WWII Gunnery Target Engine Technical Analysis Part I. Background and General Configuration*, ENGINE HISTORY (Jun. 19, 2017), http://www.enginehistory.org/Piston/WW2Drone/WW2Drone1.shtml.

[42] Nguyen, *supra* note 2; Doyle, *supra* note 13.

[43] Nguyen, *supra* note 2.

[44] *Id.*

[45] Doyle, *supra* note 13.

[46] Nguyen, *supra* note 2.

[47] Doyle, *supra* note 13.

States.[48] When the balloon-drones were released, they would reach an altitude of 30,000 feet and then would catch a jet stream that carried them across the Pacific Ocean.[49] Throughout this journey, hydrogen slowly depleted from the balloon-drones.[50] When they dropped below 25,000 feet, the altitude regulation systems would drop one of their 32 sandbags, causing the balloon-drones to rise back up to 35,000 feet.[51] This continued until all 32 paper sandbags had been dropped and the balloon-drones made their way to North America.[52] Interestingly, although the Japanese launched 9,300 balloon-drones during World War II, only 300 actually made it to North America and only six people were killed.[53]

C. UAV USAGE DURING THE VIETNAM & COLD WARS

Following World War II, the United States' use of drones grew exponentially. During the 1950s, the United States military invested in further drone development for the purpose of reconnaissance.[54] In 1948, the United States Air Force entered into an agreement with Ryan Aeronautical Company to design and to build aircraft that could simulate enemy threats.[55] As a result, Ryan Aeronautical Company provided to the United States the first jet-propelled drone ever produced, the *Ryan Firebee I*.[56] It was able to remain in the air for over two hours and could reach an altitude of 60,000 feet.[57] Using a similar design, Ryan Aeronautical Company built the *AQM-34*, which flew tens of thousands of reconnaissance missions through Vietnam, China, and the Soviet Union.[58] Similarly, after Northrop Aircraft Incorporated acquired Radioplane Company, it developed the *Northrop Radioplane RP-71 Falconer*, which used a still film camera and recorded crude video for reconnaissance missions.[59] It also developed drones such as the *Model 147 FireFly* and the *Lightning Bug* series, both of which were used heavily in Vietnam.[60]

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[48] *Id.*

[49] *Id.*

[50] *Id.*

[51] *Id.*

[52] *Id.*

[53] *Id.*

[54] Nguyen, *supra* note 2.

[55] Andrew Tarantola, *The Ryan Firebee: Grandfather to the Modern UAV*, GIZMODO (Aug. 27, 2013, 11:30 AM), https://gizmodo.com/the-ryan-firebee-grandfather-to-the-modern-uav-1155938222; T.F.J. Leversedge, *Ryan KDA-4 Firebee Target Drone RCAF Serial KD4788*, CANADA AVIATION & SPACE MUSEUM AIRCRAFT, https://documents.techno-science.ca/documents/CASM-Aircrafthistories-RyanKDA-4Firebeetargetdrone.pdf (last visited Feb. 9, 2021).

[56] *Id.*

[57] Nguyen, *supra* note 2.

[58] Doyle, *supra* note 13.

[59] *Id.*

[60] Nguyen, *supra* note 2.

After the Vietnam War, countries other than the United States, Great Britain, Germany, and Japan also began to take an interest in drones.[61] Perhaps the most notable of these countries is Israel, which began to modify existing drone technology and to develop its own models.[62] During the Yom Kippur War in October 1973, Israel deployed to Golan Heights, Syria, a "swarm" of *Northrop Chukar* drones, which gave the Syrian military the impression that it was under attack.[63] Syria's military response to this diversion tactic caused a reduction in its air defense.[64] Thereafter, the Israeli-Syrian conflict reached a boiling point.[65] In 1982, Israel used battlefield drones, alongside manned aircraft, to neutralize Syrian forces with minimal casualties.[66] Israel's drones mapped out enemy territory, jammed Syrian communications, and acted as decoys to prevent loss of life.[67]

Despite these practices, military drones were largely considered unreliable and expensive.[68] However, in 1980, the United States military commenced the Pioneer UAV Program, which was designed to construct inexpensive drones for fleet operations and was, in fact, successful in mass-producing and supplying drones.[69] In addition, Israel's successful militarized use of battlefield drones enlightened other countries, including the United States, on drone reliability and inexpensive possibilities.[70] In 1984, the United States invested tens of millions of dollars in drone contracts.[71] In 1986, a collaboration between the Israeli military and the United States military led to the construction[72] of the *Pioneer RQ-2A UAV*, a reconnaissance drone that provided real-time information regarding surveillance, battle damage, and targets.[73]

As the Cold War progressed, so did growth in drone technology.[74] Because the United States and the USSR used drones to spy on each other,[75] both turned their focus to stealthier spy aircraft, such as the *Mach 4 Lockheed*

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[61] Doyle, *supra* note 13.
[62] *Id.*
[63] *Id.*
[64] *Id.*
[65] *The History of Drones (Drone History Timeline from 1849 to 2019)*, *supra* note 1.
[66] *Id.*
[67] *Id.*
[68] Vyas, *supra* note 4.
[69] *Id.*
[70] *The History of Drones (Drone History Timeline from 1849 to 2019)*, *supra* note 1.
[71] *Id.*
[72] Vyas, *supra* note 4.
[73] *Pioneer RQ-2A UAV*, SMITHSONIAN NAT'L AIR & SPACE MUSEUM, https://airandspace.si.edu/collection-objects/pioneer-rq-2a-uav/nasm_A20000794000 (last visited Jul. 28, 2020).
[74] *The History of Drones (Drone History Timeline from 1849 to 2019)*, *supra* note 1.
[75] *Id.*

D-21 (the "D-21").[76] The United States military launched the D-21 from the top of an aircraft's fuselage, then flew it to a pre-programmed destination.[77] While carrying a camera that could capture several high-resolution images,[78] the D-21 could travel over 3,400 nautical miles at speeds of Mach 3.3 (2,500+ mph) and at a cruising altitude of 90,000 feet.[79] After taking the desired photographs, the drone would release the camera and exposed film for mid-air recovery by another aircraft, then self-destruct.[80]

D. MODERN MILITARY UAV USAGE

Until the 1990s, the United States military had not considered the possibility of using armed drones in battle.[81] In 1994, General Atomics Aeronautical Systems developed the *Predator RQ-1*, based on a former Israeli Air Force officer's drone design,[82] which was capable of remaining in the air for up to 14 hours, traveling 400 miles, and could be controlled by a satellite link from thousands of miles away.[83] Although this drone was originally developed with the intention of withstanding long reconnaissance trips, the design was so successful that, today, different *Predator RQ-1* models are used to patrol the United States-Mexico border, to aid in atmospheric research, and to fire missiles on foreign targets.[84]

In the years following the 9/11 terrorist attacks, companies such as AeroVironment, Inc. (an American technology solutions company that focuses on UAVs),[85] developed surveillance drones for operations in the Middle East.[86] Perhaps the most advanced surveillance drone in use today is the *Northrop Grumman RQ-4 Global Hawk* ("Global Hawk").[87] This high-altitude drone is considered a "long endurance aircraft" due to its ability to "fly more than 32 hours at a stretch and loiter at altitudes as high as 65,000 feet, with sensors that can see through clouds, dense fog, haze, and dust storms. Utilizing a su-

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[76] Nguyen, *supra* note 2.

[77] *Lockheed D-21 Drone*, AMARC EXPERIENCE, http://www.amarcexperience.com/ui/index.php?option=com_content&view=article&id=23:lockheed-d21-drone&catid=8:aircraft-profiles-category (last visited Jul. 27, 2020).

[78] *Id.*

[79] John Pike & Steven Aftergood, *Senior Bowl D-21 Tagboard*, FED'N OF AM. SCIENTISTS (Jun. 21, 1997), https://fas.org/irp/program/collect/d-21.htm.

[80] *Lockheed D-21 Drone*, *supra* note 77.

[81] Nguyen, *supra* note 2.

[82] Doyle, *supra* note 13.

[83] *Nguyen, supra* note 2.

[84] Doyle, *supra* note 13.

[85] *Investor Relations*, AEROVIRONMENT, https://www.investor.avinc.com/ (last visited Jul. 28, 2020).

[86] Vyas, *supra* note 4.

[87] Doyle, *supra* note 13.

per-fast data transmission rate, operators can view very high-resolution imagery of wide swaths of the ground below."[88] With these capabilities, Global Hawk has flown over 250,000 hours and has supported United States military operations throughout the Middle East.[89]

Another advanced drone that is in use today is the *Lockheed Martin RQ-170 Sentinel* ("RQ-170 Sentinel"), which Lockheed Martin Corporation developed in 2007 and the United States Air Force now operates on behalf of the United States Central Intelligence Agency (the "CIA").[90] In 2010 and 2011, the CIA, in combination with special operations forces, used this stealth drone to locate and monitor Osama bin Laden in his Abbottabad, Pakistan compound.[91] The RQ-170 Sentinel was equipped with infrared and electro-optic sensors and "an active electronically scanned array radar" ("AESA").[92] To protect a drone's stealth status, and thus make it more difficult to detect, the AESA radar system transmits signals across an array of frequencies.[93] Though the first uses of drones occurred in military settings, today, drones have a much broader application.

E. INITIAL COMMERCIAL DRONE USAGE IN THE UNITED STATES

In 2006, the Federal Aviation Administration (the "FAA") "issued the first commercial drone permit," marking the earliest use of drones for non-military purposes.[94] Thereafter, the United States government used commercial drones to assist in disaster relief efforts, to fight wildfires, and to conduct border surveillance.[95] Likewise, private companies used commercial drones to perform pipeline inspections and to spray pesticides on farmland.[96] Surprisingly, however, due to low-demand, from 2006 to 2014, the FAA only issued two commercial drone permits per year.[97]

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[88] *Id.*

[89] *Global Hawk: Vigilance for a Changing World*, NORTHROP GRUMMAN, https://www.northropgrumman.com/air/globalhawk/ (last visited Jul. 28, 2020).

[90] *Lockheed Martin Rq-170 Sentinel*, *supra* note 3.

[91] Ed Darack, *The Drone that Stalked Bin Laden*, AIR & SPACE (Apr. 2016), https://www.airspacemag.com/military-aviation/drone-staked-out-bin-ladens-neighborhood-180958482/.

[92] *RQ-170 Sentinel Unmanned Aerial Vehicle*, AIR FORCE TECH., https://www.airforce-technology.com/projects/rq-170-sentinel/ (last visited Jul. 28, 2020).

[93] *Understanding AESA: A Game-Changer in RADAR Technology*, BLILEY TECHS. (Sept. 12, 2017, 6:30 AM), https://blog.bliley.com/understanding-aesa-radar-tech.

[94] Vyas, *supra* note 4.

[95] *The History of Drones (Drone History Timeline from 1849 to 2019)*, *supra* note 1.

[96] *Id.*

[97] *Id.*

However, in 2013, Amazon, Inc. ("Amazon") changed the game of drones when it took interest in utilizing commercial drones for package delivery,[98] a service it would call, "Amazon Prime Air."[99] At the time, Amazon's then-CEO, Jeff Bezos, explained that it would "use octocopter aerial drones to deliver packages up to five pounds to any customer within ten miles of a fulfillment center."[100] Amazon's idea sparked global interest in the potential of drone technology.[101] As a result, "[i]n 2015, the FAA issued 1000 [commercial] drone permits, a number which more than tripled to 3100 [commercial drone] permits in 2016. . . ."[102] Since that time, the demand for drones has only continued to increase.[103]

II. PRESENT DAY COMMERCIAL UAV USAGE IN THE UNITED STATES

As discussed above, as early as the 19th century, military forces throughout the world have used UAVs to prepare for, and to succeed in, battle.[104] Thereafter, advances in UAV technology aroused the imagination of people across the globe. Though commercial UAVs have only existed for under a decade, several industries, a few of which are discussed below, are reaping the benefits of implementing commercial UAVs into their operations.

A. PACKAGE DELIVERIES

Since March 2019, UAVs have been shipping lab samples around WakeMed Health and Hospital's extensive campus located in Raleigh, North Carolina.[105] On the consumer side, Amazon has proposed, and other retailers have begun, using UAV package delivery to cut shipping costs and delivery times.[106] For example, using a delivery UAV to carry a 4.4-pound package to a home six miles from an Amazon warehouse would cost a mere $0.10, as

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[98] *Id.*

[99] Matt Hickey, *Meet Amazon Prime Air, A Delivery-By-Aerial-Drone Project*, FORBES (Dec. 1, 2013, 9:43 PM), https://www.forbes.com/sites/matthickey/2013/12/01/meet-amazon-prime-air-amazons-delivery-by-aerial-drone-project/#5ff5c75179b2.

[100] *Id.*

[101] *The History of Drones (Drone History Timeline from 1849 to 2019)*, *supra* note 1.

[102] *Id.*

[103] *Id.*

[104] *Id.*

[105] David Schneider, *U.S. Commercial Drone Deliveries Will Finally Be a Thing in 2020*, IEEE SPECTRUM (Jan. 1, 2020, 2:00 PM), https://spectrum.ieee.org/aerospace/aviation/us-commercial-drone-deliveries-will-finally-be-a-thing-in-2020.

[106] Cooper Smith, *SPOTLIGHT: Amazon's Delivery Drones Could Make 30-Minute Deliveries a Reality (and for a $1 fee)*, BUSINESS INSIDER (Apr. 15, 2015, 12:02 PM), https://www.businessinsider.com/amazons-delivery-drones-could-make-30-minute-deliveries-a-reality-and-for-a-1-fee-2015-4; Schneider, *supra* note 105.

opposed to ground delivery, which would cost $2.00 to $8.00 per package.[107] Importantly, and in addition to simply cutting shipping costs and delivery times, UAV package deliveries also reduce road congestion, and in turn, reduce carbon emissions.[108] Certainly, society (and the environment) will greatly benefit from the far-reaching benefits of UAV package delivery services.

B. SPORTS BROADCASTING

Hospitals and retailers are not the only businesses benefitting from commercial UAV technology. UAVs equipped with cameras give sports broadcasting companies a birds-eye view, enabling them to capture videography from places and at angles they never could with traditional methods of recording.[109] This allows journalists to film much closer to sports participants and subjects, which increases viewing pleasure and amazes the spectator.[110] For example, in 2014, UAVs were used in the Winter Olympics to broadcast the snowboarding and freestyle skiing competitions.[111] And, in 2016, over 50 UAVs were used in the Summer Olympics to capture different angles of sporting events and "give new emotional impact to sports."[112] Moreover, because sports broadcasting UAVs are small, affordable, and flexible in flight, UAVs are more attractive and practical than "traditional cable-suspended camera systems."[113] For these reasons, UAVs appear to be the future of aerial sports broadcasting.[114]

C. MARKETING PHOTOGRAPHY AND VIDEOGRAPHY

Like sports broadcasting companies, marketing companies are discovering many of the same benefits to using UAVs—decreased production costs, increased efficiency, and aerial videography.[115] Unlike traditional methods of videography that require marketing companies to rent helicopters and

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[107] Smith, *supra* note 106.

[108] Akshat Sharma, *How Future Delivery Drones Will Deliver Your Packages*, JUNGLEWORKS, https://jungleworks.com/how-future-delivery-drone-will-deliver-your-packages/ (last visited Aug. 8, 2020).

[109] Zehra Betul Ayranci, *Use of Drones in Sports Broadcasting*, 33 ABA FORUM ON THE ENT. & SPORTS INDUS. 1, 1 (May 17, 2017).

[110] *Id.*

[111] *Id.* at 2.

[112] *Id.*

[113] *Id.* at 1.

[114] *Id.*

[115] *See* AJ Agrawal, *5 Ways Marketers Can Take Advantage of Drone Technology*, FORBES (Jun. 10, 2017, 1:41 AM), https://www.forbes.com/sites/ajagrawal/2017/06/10/5-ways-marketers-can-take-advantage-of-drone-technology/#429bc4bd58cc.

cranes to capture aerial footage, UAVs allow marketers to capture videography from unique angles and heights, and at a fraction of the cost.[116] Thus, with UAV technology, real estate agents, architects, and others can capture better aerial photography and videography, which allows for improved marketing opportunities.[117]

D. FIGHTING WILDFIRES

Unlike package deliveries or sports broadcasting services that tend to benefit consumers, UAVs can also be used to save lives by helping fight wildfires.[118] In the summer of 2016, California wildfires destroyed over 8.8 million acres of property, killed over 40 people, and destroyed over 8,400 buildings.[119] In response thereto, the next summer, the Los Angeles Fire Department began using firefighting UAVs to help smother wildfires threatening neighborhoods and businesses in Los Angeles.[120]

Firefighting UAVs "can detect, contain and even extinguish fires faster and with greater safety" than other methods of firefighting.[121] By providing firefighters with an aerial view of a wildfire, UAVs allow firefighters to make quick decisions about where the fire may spread, where to fight the fire, and which neighborhoods need to be evacuated.[122] In addition, unlike helicopters or airplanes that are "used to survey wildfires and drop retardant [but] can't fly in poor conditions – and [are] often in short supply," firefighting UAVs are readily available, able to fly through smokey conditions, and provide "an opportunity to gather intelligence at a time when [firefighters] wouldn't be able to gather it any other way."[123] UAVs can do so because they are equipped with infrared cameras and sensors that observe wind direction and other weather variables, and are able to fit through canyons and other confined spaces.[124] Thus, from medical-related deliveries in Raleigh, North Carolina, to fighting wildfires in Los Angeles, California, UAVs are revolutionizing the ways in which society operates.

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[116] *Id.*

[117] *Id.*

[118] *See* Kate Baggaley, *Drones are fighting wildfires in some very surprising ways*, NBC NEWS (Nov. 16, 2017, 8:14 AM), https://www.nbcnews.com/mach/science/drones-are-fighting-wildfires-some-very-surprising-ways-ncna820966.

[119] *Id.*

[120] *Id.*

[121] *Id.*

[122] *Id.*

[123] *Id.* (quoting Brad Koeckeritz, chief of the Interior Department's unmanned aircraft systems division).

[124] *Id.*

III. CURRENT UAV TECHNOLOGY

As evidenced above, it is clear that UAVs are becoming more prevalent in today's society. But what exactly is a UAV? UAVs comprise many different technological parts, each of which are essential for proper operation and flight.[125] While some parts protect the UAV from damage, other parts ensure a smooth flight pattern.[126] Simply put, the UAV system includes "the drone itself and the control system."[127] And, as part of the control system, each commercial UAV is controlled through a ground control, or a hand-held remote device.[128]

A. FLIGHT COMPONENTS

Although each UAV is equipped with different technology, the following components present a general depiction of current UAV technology.

1. UAV Body Size

UAVs come in a wide variety of configurations and sizes.[129] The smallest UAVs, like DJI's Mavic Air 2,[130] which measures 302 millimeters (or 11.89 inches) diagonally,[131] are used for recreational purposes and can be launched vertically from the palm of the controller's hand.[132] In terms of commercial UAVs, the most common design is a small to medium-sized build called a quadcopter, which is propelled by four motors and propellers (two sets that rotate clockwise and two sets that rotate counterclockwise) and lifts off vertically.[133] Commercial UAVs, like DJI's P4 Multispectral—"a high-precision drone" that is used to "gather precise plant-level data . . . for agricultural missions [and] environmental monitoring," measure around 350 millimeters (or approximately 13.8 inches) diagonally and are slightly larger than

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[125] Fintan Corrigan, *Quick Drone Parts Overview Along With Handy DIY Tips*, DRONEZON (May 9, 2020), https://www.dronezon.com/learn-about-drones-quadcopters/drone-components-parts-overview-with-tips/.

[126] Fintan Corrigan, *How Do Drones Work and What is Drone Technology*, DRONEZON (June 7, 2020), https://www.dronezon.com/learn-about-drones-quadcopters/what-is-drone-technology-or-how-does-drone-technology-work/.

[127] *Id.*

[128] *Id.* In fact, the French company, Parrot, developed the first drone that could be controlled using a Wi-Fi connection on a smartphone—Parrot AR Drone. Dormehl, *supra* note 6.

[129] *How Do Drones Work and What is Drone Technology*, *supra* note 126.

[130] *Mavic Air 2*, DJI, https://www.dji.com/mavic-air-2 (last visited Jan. 30, 2021).

[131] Mavic Air 2, DJI, https://www.dji.com/mavic-air-2/specs (last visted Jan. 30, 2021); Fintan Corrigan, *DJI Mavic Air 2 Review of Features, Specs and FAQs*, DroneZon (Oct. 25, 2020), https://www.dronezon.com/drone-reviews/dji-mavic-air-2-review-includes-features-specs-faqs/.

[132] *How Do Drones Work and What is Drone Technology*, *supra* note 126.

[133] *Id.*

recreational-use UAVs.[134] The next largest commercial UAVs "are unmanned aircraft, which have fixed wings and require short runways."[135] These unmanned aircraft are able to screen large areas of land and are often used to prevent wildlife poaching or to perform geographical surveying.[136] While there are many varieties of fixed-wind UAVs, the most popular size is a medium fixed-wing UAV, such as the Volantex Firstar V2, which "has a wingspan of approximately 80 [inches] and weighs around 7 pounds with no payload."[137] The largest UAVs, such as the Predator RQ-1, which has a wingspan of 48.7 feet and a length of 27 feet,[138] are used for military operations like the ones described above.[139]

2. *UAV Gyroscope Stabilization*

UAVs also generally include gyroscope stabilization technology. "A gyroscope is a device that uses Earth's gravity to help determine orientation."[140] To provide "smooth flight capabilities," gyroscope stabilization technology functions instantaneously against outside forces, such as strong wind gusts and gravity, and allows the UAV to hover and to take steep, angled turns.[141] To improve those flight capabilities, the gyroscope sends navigational information to the UAV's Inertial Measurement Unit ("IMU") and the central flight controller.[142]

3. *The Internal Measurement Unit ("IMU")*

The gyroscope described above is typically integrated within the IMU, which is a sensor that monitors rotational aspects of flight, such as roll, yaw, and pitch.[143] The IMU detects these rotational attributes through the use of accelerometers,[144] which "measure non-gravitational acceleration."[145] IMU processors continuously measure a UAV's position by calculating its velocity

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[134] *P4 Multispectral- Plant Intelligence for Targeted Action*, DJI, https://www.dji.com/p4-multispectral (last visted Feb. 9, 2021).

[135] *How Do Drones Work and What is Drone Technology*, *supra* note 126.

[136] *Id.*

[137] *Types of Drones – Fixed Wing*, 911 SEC., https://www.911security.com/learn/airspace-security/drone-fundamentals/types-of-drones-fixed-wing (last visited Feb. 5, 2021).

[138] *Predator RQ-1/ MQ-1/ MQ-9* UAV, ARMY TECH., https://www.army-technology.com/projects/rq1-predator/ (last visited Feb. 9, 2021).

[139] *How Do Drones Work and What is Drone Technology*, *supra* note 126.

[140] Ryan Goodrich, *Accelerometer vs. Gyroscope: What's the Difference?*, LIVESCIENCE (May 31, 2018), https://www.livescience.com/40103-accelerometer-vs-gyroscope.html.

[141] Fintan Corrigan, *Drone Gyro Stabilization, IMU and Flight Controllers Explained*, DRONEZON (May 7, 2020), https://www.dronezon.com/learn-about-drones-quadcopters/three-and-six-axis-gyro-stabilized-drones/.

[142] *Id.*

[143] *How Do Drones Work and What is Drone Technology*, *supra* note 126.

[144] *Drone Gyro Stabilization, IMU and Flight Controllers Explained*, *supra* note 141.

[145] Goodrich, *supra* note 140.

from its acceleration and estimated gravitational pull.[146] The flight controller then uses this information to determine the amount of speed and thrust needed to hover or to fly.[147]

4. *The Flight Controller*

As set forth above, a gyroscope is a component of the IMU, and the IMU is a component of the flight controller.[148] The flight controller (not to be confused with a hand-held controller used by a pilot) is the central brain, or computer, of the UAV.[149] This component receives signals from the hand-held controller, sends operational information to the body of the UAV, and allows the UAV to operate according to the pilot's directions.[150] It functions as the translator between the hand-held controller and the body of the UAV.[151] This allows the pilot to manipulate the UAV's movements and functions.[152]

5. *Collision Avoidance Technology*

In addition to the flight components set forth above, many UAVs are also equipped with collision avoidance technology, which uses obstacle detection to scan a UAV's surroundings.[153] To sense and to avoid objects throughout a UAV's flight, this technology uses a combination of ultrasonic, infrared, lidar, "Time of Flight" ("ToF"), and monocular vision sensors.[154] Some UAVs provide obstacle sensing on all six sides of the UAV through the combined use of vision and infrared sensors, called "omni-directional Obstacle Sensing."[155] Other UAVs utilize an "Advanced Pilot Assistance System" ("APAS") to avoid, fly forward or backward around, or hover in front of, an object.[156]

B. LOCATION-AWARE TECHNOLOGY

In addition to the flight components, each UAV is equipped with location-awareness technology, such as internal compasses, return to home,

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[146] *Drone Gyro Stabilization, IMU and Flight Controllers Explained*, *supra* note 141.

[147] *Id.*; *How Do Drones Work and What is Drone Technology*, *supra* note 126.

[148] *How Do Drones Work and What is Drone Technology*, *supra* note 126.

[149] *Drone Gyro Stabilization, IMU and Flight Controllers Explained, supra* note 141.

[150] *Id.*; *How Do Drones Work and What is Drone Technology*, *supra* note 126.

[151] Zacc Dukowitz, *Drone Controllers: A Look at How They Work, Important Terminology, and Why They're Unique in the RC Aircraft World*, UAV COACH (Sept. 19, 2019), https://uavcoach.com/drone-controller/.

[152] *See id.*

[153] *How Do Drones Work and What is Drone Technology*, *supra* note 126.

[154] *Id.*

[155] *Id.*

[156] *Id.*

"Global Positioning System" ("GPS"), and no fly zone technology.[157] An internal compass provides the exact flight location of the UAV and is calibrated to set a "home point" (or the return location of the UAV).[158] In the event of a low battery or signal loss between the UAV and the hand-held controller, the UAV will automatically return to the designated home point.[159] In addition, the pilot can initiate the "Return to Home" function by pressing a button on the hand-held controller.[160]

Generally, once the internal compass has been calibrated, the UAV searches for the location of more than six GPS satellites and enters "Ready to Fly" mode.[161] A GPS module "combines a GPS receiver and a magnetometer to provide [the flight controller with] latitude, longitude, elevation, and compass heading," which is essential for long-distance travel and in-flight information.[162] This GPS technology also allows UAV manufacturers to include a "No Fly Zone" feature, which prevents the UAV from flying into restricted air space.[163]

C. PHOTOGRAPHY & 3-D MAPPING TECHNOLOGY

Often times, commercial UAVs are used to capture aerial photography. In such circumstances, a camera is mounted to the underbody of the UAV by an anti-drop kit, which attaches the camera and the camera's stabilizing components to the UAV.[164] To capture quality photographs, UAVs are also equipped with gimbals, which allow the camera to tilt during flight and reduce camera vibration.[165] Gimbals integrated with optical and digital zoom allow UAV manufacturers to equip UAVs with zoom cameras.[166] This technology allows industrial-use UAV pilots, such as those "inspecting cell towers or wind turbines[,] to get a very detailed look at structures, wires, modules and components to detect damage."[167] Commercial UAVs can also be used to take measurements to produce 3-D maps, drawings, or models of real-world objects or plots of land.[168] To do so, the pilot flies the UAV around the

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[157] *Id.*

[158] *Id.*

[159] *Id.*

[160] *Id.*

[161] *Id.*

[162] *Quick Drone Parts Overview Along With Handy DIY Tips*, *supra* note 125.

[163] *How Do Drones Work and What is Drone Technology*, *supra* note 126.

[164] *Id.*

[165] *Id.*

[166] *Id.*

[167] *Id.*

[168] *Quick Drone Parts Overview Along With Handy DIY Tips*, *supra* note 125.

target object or plot of land, takes photographs, and then uses software to stitch together the photographs.[169]

Over the past decade, drone technology has advanced exponentially primarily due to a growing demand for commercial UAV use.[170] Manufacturers are developing UAVs with capabilities never before thought possible. Thus, because commercial UAVs are being used in countless ways and in several industries throughout the world, these unmanned aircraft are truly the technology of the future.

IV. UAV REGULATIONS

To promote the safe integration of UAVs into the national airspace system, Congress passed the FAA Modernization and Reform Act of 2012 (the "FAA Act"), which required the FAA to establish an exhaustive regulatory scheme to manage "civil small [UAVs] within the United States."[171] Thereunder, the FAA implemented Federal Regulation Part 107 – Small Unmanned Aircraft Systems ("Part 107"), which is a set of rules that apply to the operation of small unmanned aircraft systems ("sUAS").[172] An sUAS is a small unmanned aircraft that weighs less than 55 pounds at takeoff, including all components attached to the body of the aircraft.[173] Thus, Part 107 sets forth the rules and regulations for typical commercial UAV operation.[174]

A. PART 107 - OPERATING RULES

Part 107 provides a series of operating rules to ensure the safe operation of an sUAS.[175] Thereunder, an sUAS must be operated as set forth in this section below.[176] It is important to note, however, that in the event of "an inflight emergency requiring immediate action, the remote pilot in command [("RPC")] may deviate from" the rules listed below, but only "to the extent necessary to meet that emergency."[177]

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[169] *Id.*

[170] *How Do Drones Work and What is Drone Technology*, *supra* note 126.

[171] Hadas Livnat, Annotation, *Federal Regulation of Civil Unmanned Aircraft Systems ("Drones")*, 31 A.L.R. Fed. 3d Art. 9, § 2 (2018).

[172] *Id.*; 14 C.F.R. § 107.1 (2020).

[173] 14 C.F.R. § 107.3 (2020).

[174] *See generally* 14 C.F.R. § 107 (2020).

[175] 14 C.F.R. § 107.11 (2020).

[176] *Id.*

[177] 14 C.F.R. § 107.21 (2020).

As a preliminary matter, prior to and during each flight, the sUAS must be "in a condition for safe operation," as determined by the RPC.[178] Moreover, an sUAS may not be operated at night[179] or during "civil twilight," which includes the 30-minute periods before sunrise and after sunset.[180] Next, a person may not operate an sUAS or serve as a direct participant, an RPC, or a visual observer ("VO"), if he or she has a medical condition that would hinder his or her ability to safely operate or safely participate in the operation of the sUAS.[181] Similarly, a person may not operate an sUAS or serve as an RPC, a VO, or direct participant, if he or she is under the influence of alcohol or drugs.[182]

During the flight, the sUAS' groundspeed must not exceed 100 mph.[183] Also, its altitude "cannot be higher than 400 feet above ground level" unless it "[i]s flown within a 400-foot radius of a structure" and stays below "400 feet above the structure's immediate uppermost limit."[184] Moreover, the minimum flight visibility[185] must be at least three miles[186] and the sUAS must remain "500 feet below" a cloud and "2,000 feet horizontally away from" a cloud.[187]

Finally, a person may not operate an sUAS in a "careless or reckless manner," including by dropping objects from the sUAS that would create "an undue hazard" to others,[188] carrying hazardous materials,[189] operating the sUAS over another human being,[190] or operating the sUAS in Class B, C, D, or E airspace without "prior authorization from Air Traffic Control."[191] One other such general prohibition includes operating an sUAS from a moving vehicle, whether it be an aircraft or an automobile.[192] However, a person may operate an sUAS from a moving automobile if the operation takes place in a

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[178] 14 C.F.R. § 107.15 (2020).

[179] 14 C.F.R. § 107.29 (2020). However, a person may operate an sUAS during civil twilight if the sUAS is equipped with anti-collision lighting with at least three miles of visibility. *Id.*

[180] *Id.*

[181] 14 C.F.R. § 107.17 (2020).

[182] 14 C.F.R. § 107.27 (2020); *see* 14 C.F.R. § 91.17 (2019); *see* 14 C.F.R. § 91.19 (2020).

[183] 14 C.F.R. § 107.51 (2020).

[184] *Id.*

[185] "[F]light visibility means the average slant distance from the control station at which prominent unlighted objects may be seen and identified by day and prominent lighted objects may be seen and identified by night." 14 C.F.R. § 107.51(c) (2020).

[186] *Id.*

[187] *Id.* § 107.51(d).

[188] 14 C.F.R. § 107.23 (2020).

[189] 14 C.F.R. § 107.36 (2020).

[190] 14 C.F.R. § 107.39 (2020). However, a person may operate an sUAS over human beings whom are "directly participating in the operation of the" sUAS or are "located under a covered structure." *Id.*

[191] 14 C.F.R. § 107.41 (2020).

[192] 14 C.F.R. § 107.25 (2020).

"sparsely populated area" and it "is not transporting another person's property for compensation or hire."[193] Moreover, to determine the sUAS' location, altitude, and direction, an sUAS must be visible during the entire operation without the aid of any device.[194] For that reason, a person may not operate, serve as RPC of, or serve as a VO of, more than one sUAS at a time,[195] and all such individuals must continuously and effectively communicate.[196]

B. PART 107 – REMOTE PILOT CERTIFICATION

In addition to the operating rules set forth above, Part 107 also provides a series of certification requirements and responsibilities for the RPC.[197] Thereunder, a person may only operate an sUAS if he or she: (1) "has a remote pilot certificate with [an sUAS] rating[;]" or (2) is directly supervised by an RPC who "has the ability to immediately take direct control of the flight of the" sUAS.[198] To qualify for a remote pilot certification with an sUAS rating, an individual must: (1) demonstrate knowledge of aeronautics,[199] (2) "read, speak, write, and understand the English language[,]"[200] (3) be at least 16 years old,[201] and (4) have no mental or physical health conditions "that would interfere with the safe operation of" the sUAS.[202] Moreover, to demonstrate that the individual seeking a remote pilot certification with an sUAS rating has sufficient aeronautical knowledge, he or she must either (1) "[p]ass an initial aeronautical knowledge" exam, or (2) hold a Part 61 pilot certification and take an FAA sUAS training course.[203]

Once the remote pilot certification with an sUAS rating has been obtained, upon request from the FAA, the RPC must make available for inspection or evaluation its sUAS, its RPC certification, and all corresponding documentation.[204] In addition, the RPC must ensure that the sUAS is registered with the FAA and complies with all registration requirements.[205] Furthermore, in the event of a flight operation that causes serious injury, "loss of

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[193] 14 C.F.R. § 107.25(b) (2020).
[194] 14 C.F.R. § 107.31 (2020).
[195] 14 C.F.R. § 107.35 (2020).
[196] 14 C.F.R. § 107.33 (2020).
[197] *See* 14 C.F.R. § 107.53 (2020).
[198] 14 C.F.R. § 107.12(a)(2) (2020).
[199] 14 C.F.R. § 107.61(d) (2020).
[200] *Id.* § 107.61(b).
[201] *Id.* § 107.61(a).
[202] *Id.* § 107.61(c).
[203] *Id.*
[204] 14 C.F.R. § 107.7 (2020).
[205] 14 C.F.R. § 107.13 (2020); *see* 14 C.F.R. § 91.203 (2020).

consciousness," or property damage of $500 or greater, the RPC must disclose the incident to the FAA within ten days.[206]

C. STATE UAV REGULATIONS

In addition to the federal UAV regulations set forth above, 42 of the 50 states have enacted some form of UAV regulations.[207] Those states include Alaska,[208] Arizona,[209] Arkansas,[210] California,[211] Colorado,[212] Connecticut,[213] Delaware,[214] Florida,[215] Georgia,[216] Hawaii,[217] Idaho,[218] Illinois,[219] Indiana,[220] Kansas,[221] Kentucky,[222] Louisiana,[223] Maine,[224] Maryland,[225] Michigan,[226] Minnesota,[227] Mississippi,[228] Montana,[229] Nevada,[230] New Hampshire,[231] New Jersey,[232] North Carolina,[233] North Dakota,[234] Ohio,[235]

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[206] 14 C.F.R. § 107.9 (2020).

[207] *Current Unmanned Aircraft State Law Landscape*, NAT'L CONF. OF STATE LEGISLATURES (Jan. 20, 2021), https://www.ncsl.org/research/transportation/current-unmanned-aircraft-state-law-landscape.aspx.

[208] *See, e.g.*, ALASKA STAT. § 18.65.900 (2020).

[209] *See, e.g.*, ARIZ. REV. STAT. ANN. § 26-314 (2020).

[210] *See, e.g.*, ARK. CODE ANN. § 5-60-103 (West 2020).

[211] *See, e.g.*, CAL. PENAL CODE § 647(j)(1) (West 2020).

[212] *See, e.g.*, COLO. REV. STAT. ANN. § 18-8-104 (West 2020).

[213] *See, e.g.*, CONN. GEN. STAT. § 7-149b (2020).

[214] *See, e.g.*, DEL. CODE ANN. tit. 11, § 1256 (2020); *id.* § 1334.

[215] *See, e.g.*, FLA. STAT. § 330.41 (2020).

[216] *See, e.g.*, GA. CODE ANN. § 42-5-18 (2020).

[217] *See, e.g.*, HAW. REV. STAT. § 132D-14 (2020); *id.* § 132D-14.5.

[218] *See, e.g.*, IDAHO CODE § 36-1101 (2020).

[219] *See, e.g.*, 725 ILL. COMP. STAT. 167 (2020).

[220] *See, e.g.*, IND. CODE § 35-33-5-9 (2020).

[221] *See, e.g.*, S. Res. 1759, 2017-2018 Reg. Sess. (Kan. 2018); *see* KAN. STAT. ANN. § 60-31a02 (2021).

[222] *See, e.g.*, KY. REV. STAT. ANN. § 511.100 (West 2020); *id.* § 520.010.

[223] *See, e.g.*, LA. STAT. ANN. § 14:283 (2020).

[224] *See, e.g.*, ME. REV. STAT. tit. 25, § 4501 (2020).

[225] *See, e.g.*, MD. CODE ECON. DEV. § 14-301 (West 2020).

[226] *See, e.g.*, MICH. COMP. LAWS ANN. § 259.305 (West 2020).

[227] *See, e.g.*, MINN. STAT. § 626.19 (2020).

[228] *See, e.g.*, MISS. CODE ANN. § 97-29-61 (West 2020).

[229] *See, e.g.*, MONT. CODE ANN. § 46-5-109 (2020).

[230] *See, e.g.*, NEV. REV. STAT. § 231.1525 (2020).

[231] *See, e.g.*, N.H. REV. STAT. ANN. § 207:57 (2020).

[232] *See, e.g.*, N.J. STAT. ANN. § 24:61-20(h)(4) (West 2020).

[233] *See, e.g.*, N.C. GEN. STAT. § 15A-300.3 (2020).

[234] *See, e.g.*, N.D. CENT. CODE § 29-29.4-01 to -06 (2020).

[235] *See, e.g.*, OHIO REV. CODE ANN § 122.98 (West 2020).

Oklahoma,[236] Oregon,[237] Pennsylvania,[238] Rhode Island,[239] South Carolina,[240] South Dakota,[241] Tennessee,[242] Texas,[243] Utah,[244] Vermont,[245] Virginia,[246] West Virginia,[247] Wisconsin,[248] and Wyoming.[249]

For example, Wisconsin has an outright ban on weaponized UAVs.[250] And in states such as Iowa, Minnesota, Utah, and North Dakota, the legislatures have each enacted tight restrictions on government agencies' uses of UAVs and the evidence resulting therefrom.[251] Other states, such as South Dakota, simply enacted legislation requiring UAV usage to "comply with all applicable [FAA] regulations."[252] Interestingly, however, South Dakota also expressly allows the use of UAVs in hunting to locate or spot "a predator or varmint,"[253] and expressly prohibits the use of UAVs "over the grounds of a prison, correctional facility, jail, juvenile detention facility, or any military facility"[254] and "to deliver contraband or controlled substances to a state prison or other correctional facility. . . ."[255]

Thus, while many states have begun to mildly limit non-commercial drone usage, state-level regulations on the commercial use of drones is limited, at best. Because UAVs "are aircraft subject to regulation by the FAA," any state law that is inconsistent "with applicable federal safety regulations"

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[236] *See, e.g.*, OKLA. STAT. tit. 3, § 322 (2020).

[237] *See, e.g.*, OR. REV. STAT. § 837.360 (2020); *id.* § 837.374.

[238] *See, e.g.*, 18 PA. STAT. AND CONS. STAT. ANN. § 3505 (West 2020).

[239] *See, e.g.*, 1 R.I. GEN. LAWS § 1-8-1 (2020).

[240] *See, e.g.*, S.C. CODE ANN. § 24-1-320 (2020).

[241] *See, e.g.*, S.D. CODIFIED LAWS § 50-15-2 (2020).

[242] *See, e.g.*, TENN. CODE ANN. § 39-13-903(a)(3) (West 2020).

[243] *See, e.g.*, TEX. GOV'T CODE ANN. §423.002 (West 2019).

[244] *See, e.g.*, UTAH CODE ANN. § 72-14-203 (West 2020).

[245] *See, e.g.*, VT. ADMIN. CODE 16-4-159:4.0 (2020).

[246] *See, e.g.*, VA. CODE ANN. § 18.2-121.3 (2020).

[247] *See, e.g.*, W. VA. CODE § 61-16-2 (2020).

[248] *See, e.g.*, WIS. STAT. § 941.292 (2020).

[249] *See, e.g.*, WYO. STAT. ANN. § 10-3-201 to -301 (West 2020); *id.* § 10-4-303.

[250] *See* WIS. STAT. § 941.292(2) (2020).

[251] *See* IOWA CODE § 808.15 (2020) (stating that "[i]nformation obtained as a result of the use of an unmanned aerial vehicle is not admissible as evidence in a criminal or civil proceeding, unless the information is obtained pursuant to the authority of a search warrant, or unless the information is otherwise obtained in a manner that is consistent with state and federal law"); *see* MINN. STAT. § 626.19 (2020); *see* UTAH CODE ANN. § 72-14-203 (West 2020); *see* N.D. CENT. CODE § 29-29.4-02 (2020) (stating that data obtained from a UAV is "not admissible in a prosecution or proceeding within the state unless the information was obtained" through "a search warrant" or "[i]n accordance with exceptions to the warrant requirement").

[252] S.D. CODIFIED LAWS § 50-15-2 (2020).

[253] S.D. CODIFIED LAWS § 41-8-39 (2020).

[254] S.D. CODIFIED LAWS § 50-15-3 (2020).

[255] *Id.* § 50-15-4.

will prove problematic for state legislatures.[256] To that end, "[c]ourts have found that state regulation[s] pertaining to mandatory training and equipment requirements related to aviation safety [are] not consistent with the federal regulatory framework."[257] Courts also "strictly scrutinize state and local regulation of overflight."[258] Thus, to avoid preemption issues, states will likely remain silent on the topic of commercial usage of UAVs. Put another way, "[a] consistent regulatory system for aircraft and use of airspace has the broader effect of ensuring the highest level of safety for all aviation operations."[259]

V. REDUCING THE RISK OF LITIGATION THROUGH UAV USE

Undoubtedly, UAVs benefit society in a number of ways. But how can commercial UAVs be used to benefit companies before and during potential legal disputes? As detailed below, different industries, such as construction, energy, and agriculture, can use commercial UAV technology to reduce the risk of litigation.[260]

One of the greatest benefits of commercial UAV technology is access to instantaneous and accurate visual information, which can then be used in several different ways.[261] As set forth above, most commercial UAVs collect high definition images and use scanning functions that gather various types of visual data, more frequently and of a better quality than satellites.[262] This visual data can be used in many different ways, including to assist in construction project pre-planning, progress tracking, and safety, to inspect photovoltaic solar panels and wind turbines, and to assess crop damage.[263]

A. THE CONSTRUCTION INDUSTRY

Construction, the second largest industry in the world, is worth approximately $8 trillion per year, but is severely inefficient.[264] In fact, the average

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[256] *See State and Local Regulation of Unmanned Aircraft Systems (UAS) Fact Sheet*, FEDERAL AVIATION ADMINISTRATION 1 (Dec. 17, 2015), https://www.faa.gov/uas/resources/policy_library/media/UAS_Fact_Sheet_Final.pdf.

[257] *Id.* at 3 (citing Med-Trans Corp. v. Benton, 581 F. Supp. 2d 721, 740 (E.D.N.C. 2008); Air Evac EMS, Inc. v. Robinson, 486 F. Supp. 2d 713, 722 (M.D. Tenn. 2007)).

[258] *Id.* (citing City of Burbank v. Lockheed Air Terminal, 411 U.S. 624 (1973); Skysign Int'l, Inc. v. City and County of Honolulu, 276 F.3d 1109, 1117 (9th Cir. 2002); American Airlines v. Town of Hempstead, 398 F.2d 369 (2d Cir. 1968); American Airlines v. City of Audubon Park, 407 F.2d 1306 (6th Cir. 1969)).

[259] *Id.* at 2.

[260] *Drone Technology*, THOMPSON TRACTOR, https://thompsontractor.com/about/resources-(1)/drone-technology (last visited Aug. 1, 2020).

[261] *See id.*

[262] *The Drone Economy in the Construction Industry*, JDSUPRA (May 30, 2017), https://www.jdsupra.com/legalnews/the-drone-economy-in-the-construction-58693/.

[263] *See infra* Section V.A – C.

[264] *The Drone Economy in the Construction Industry*, *supra* note 262.

major "construction project runs 80% over budget"[265] and "take[s] 20 percent longer than originally scheduled."[266] Thus, while the industry, as a whole, appears successful, individual construction projects are a different story.[267] This disconnect is where commercial UAVs have the potential to flourish by providing cost and time saving measures.[268]

1. Construction Pre-Planning

Visual information gathered by commercial UAVs helps construction companies understand their project site before starting construction.[269] For example, UAVs collect information that allows design teams to determine the orientation of structures and the location of the utilities on the project site.[270] This pre-planning information, which includes variations in elevation and drainage points, helps architects and construction personnel determine appropriate locations to build, dig, or stockpile materials.[271] The models and maps that are created through UAV-captured data allow for finer iteration, higher functionality, and more precise bids throughout the pre-construction stage.[272]

2. Construction Progress Tracking

Construction projects are often massive operations, and visual data is the only means by which construction personnel understand various on-site conditions.[273] Normally, construction personnel would need to gather visual information by inspecting a project site on foot.[274] However, this process usually takes hours to complete, and human error often leads to expensive inaccuracies.[275] On the other hand, a commercial UAV can gather the same visual information in a fraction of the time, and the visual information the UAV collects is more in-depth and precise.[276] For example, during a UAV's

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[265] *Id.*

[266] Tara Callinan, *How to Deal with Project* Overrun, FIELDWIRE (Nov. 13, 2018), https://www.fieldwire.com/blog/how-to-deal-with-cost-overrun-as-a-construction-project-owner/.

[267] *The Drone Economy in the Construction Industry*, *supra* note 262.

[268] *Id.*

[269] Jacqueline DeCamera & Daniel D. McMillan, *Use of Drones on Construction Projects: Legal and Contractual Considerations*, ABA (Dec. 9, 2019), https://www.americanbar.org/groups/construction_industry/publications/under_construction/2019/winter2019/use-of-drones-on-construction-projects/.

[270] *Id.*

[271] *Id.*

[272] *Drone Technology*, *supra* note 260.

[273] *Id.*

[274] *Id.*

[275] *See id.*

[276] *Id.*

flight, it can take thermal images over a construction site, which can be converted into maps and 3-D models[277] that allow the project development team to "identify a multitude of issues that are invisible to the human eye."[278]

In addition to thermal images, visual data obtained from the commercial UAV shows numerous site characteristics, such as crane positions, erection sequences, stockpile locations, perimeter security, and workable spaces.[279] This information can expose the point in which projects are becoming crowded or delayed,[280] a frequently litigated topic in commercial construction cases. Site maps can also assist project managers in monitoring the productivity of personnel, locating missing machinery or equipment, and investigating why a project is delayed.[281] With UAV visual data, the project manager can analyze a map, zoom in on, and examine, a specific area of the project site, and immediately address the issue, regardless of the location of the project site.[282]

From a client-management perspective, aerial maps, photographs, videos, and 3-D models, produced using commercial UAV visual information, may be sent to owners on a regular basis.[283] This is attractive to owners who want to be frequently notified regarding the progress of a given project.[284] Traditionally, to see how a project is evolving, one would need to walk the construction site by foot or expend an enormous amount of money to hire a helicopter to capture aerial photographs of the site.[285] UAVs provide construction companies and owners with a more inexpensive and expeditious manner for project updates.[286]

From a litigation perspective, the greatest benefit of commercial UAV imaging is that it preserves evidence in the form of a permanent visual record of a construction project, something that may be referred to as necessary.[287] Moreover, if a portion of the work on a construction project is defective, then all parties involved can refer to the UAV-created maps and 3-D models to further understand what led to the defective work.[288] Thus, the visual data that depicts the continued progress and condition of a construction project

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[277] *The Drone Economy in the Construction Industry*, *supra* note 262.

[278] Brett Kanda, *Thermal Drone Market is Rapidly Expanding*, GEOSPATIAL WORLD (Mar. 7, 2019), https://www.geospatialworld.net/blogs (search in search bar for "Thermal Drone Market is Rapidly Expanding").

[279] DeCamera & McMillan, *supra* note 269.

[280] *Id.*

[281] *Id.*

[282] *See Drone Technology*, *supra* note 260.

[283] *Id.*

[284] *See id.*

[285] Kanda, *supra* note 278; *see Drone Technology*, *supra* note 260.

[286] *See Drone Technology*, *supra* note 260.

[287] *Id.*

[288] *See id.*

reduces the risk of litigation and allows construction companies and/or owners to better defend against any disputes initiated against them.[289]

3. *Construction Safety and Security*

For construction companies, the safety of their workers is paramount. Commercial UAVs collect visual information substantially quicker and cheaper than construction personnel would by foot.[290] Therefore, through the use of UAVs, construction companies are able to conduct inspections more frequently, which assist in discovering changing site conditions that may affect worker safety.[291] Additionally, drones can quickly and safely verify the location of assets and stockpiles of materials, instead of requiring construction personnel to navigate the project site on foot.[292] Frequent UAV inspections can also reveal unintended access points on a large project site where trespassers could enter and inadvertently harm themselves.[293] Thus, commercial UAVs allow construction companies to reduce their risk of litigation through effective pre-planning and progress tracking and by addressing safety and security issues.[294]

B. THE ENERGY INDUSTRY

Like construction companies, some of the largest energy companies in the world are benefitting from the use of commercial UAVs in their operations.[295] For planning and monitoring photovoltaic project sites, thermal imaging is used to "instantly identify defective or inefficient panels based on temperature differences. Cells on photovoltaic modules, entire modules or even sets of modules (known as strings) appear hotter than those that are performing as expected."[296] From these images, solar energy companies are able to generate reports that identify commonly litigated issues such as physical damage to equipment, "[c]ell-level defects and degradation," storm damage, racking shifts, shading changes, and vegetation encroachment.[297] This data

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[289] *Id.*

[290] *Id.*

[291] *Id.*

[292] *Id.*

[293] *See generally id.*

[294] *See generally id.*

[295] *Drones: Unmanned Aircraft Systems (UAS) Uplifting Operational Performance*, XCEL ENERGY, https://www.xcelenergy.com/energy_portfolio/innovation/drones (last visited Jul. 7, 2020) [hereinafter referred to as "XCEL ENERGY"].

[296] Kanda, *supra* note 278.

[297] *Drone-Based Inspections for Solar Assets*, PRECISIONHAWK, https://www.precisionhawk.com/solar (last visited Aug. 3, 2020).

allows others, such as insurance adjusters, attorneys, or fact finders, to assess claims relating to the photovoltaic projects.[298]

Similarly, commercial UAV technology enhances wind turbine inspections.[299] "[R]otor blades must be regularly inspected at least once every four years to verify their structural integrity."[300] Such inspections are difficult because owners, Operations and Maintenance ("O&M") providers, and insurance claims adjusters must "rely on rope access technicians and ground-based cameras to check for cracks, tip erosion, delamination, and other issues."[301] However, with the use of a UAV, an automated flight path can be generated "so that the [UAV] automatically flies around the wind turbine with precise distance and trajectory parameters."[302] Thereafter, the visual information collected by the UAV can be converted into a comprehensive report, which outlines defects in the wind turbines structure, such as damage from lightning strikes, cracking or splitting along joints, pitch errors, and degradation.[303] Thus, "[UAV] inspections reduce safety risk by cutting in half (or more) the number of times a turbine needs to be climbed."[304] In addition, "[b]y attaching thermal imaging cameras to drones, it is possible to detect subsurface defects in composite materials, including delamination, inclusions, faulty bonding in the loadbearing web-flange joints, and shrinkage cavities,"[305] which can detect defects before any serious structural damage or total failure of the facility occurs.[306]

Additional benefits of commercial UAV use in the energy industry include increased safety, enhanced reliability for customers, and maximized efficiency.[307] For example, Xcel Energy Inc. ("Xcel"), which operates and inspects "320,000 miles of electricity and natural gas infrastructure, thousands of substations, and dozens of power plants" uses UAV technology to inspect "transmission lines, substations, gas pipelines, power plant boilers [and] wind farm components. . . ."[308] Using UAVs instead of traditional

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[298] *See id.*

[299] *See id.*

[300] Britta Rollert, *Inspecting Rotor Blades with Thermography and Acoustic Monitoring*, FRAUNHOFER-GESELLSCHAFT (Dec. 1, 2017), https://www.fraunhofer.de/en/press/research-news/2017/december/inspecting-rotor-blades-with-thermography-and-acoustic-monitoring.html.

[301] *Drone-Based Inspections for Wind Turbine Blades*, PRECISIONHAWK, https://www.precisionhawk.com/wind (last visited Aug. 3, 2020).

[302] *Grid and Wind Turbine Inspections Made Easy by Drone Solutions*, DJI ENTERPRISE, enterprise.dji.com/news/detail/grid-and-wind-turbine-inspections-made-easy-by-drone (last visited Oct. 30, 2020).

[303] *Drone-Based Inspections for Wind Turbine Blades*, *supra* note 301.

[304] *Id.*

[305] *Id.*; *see also* Rollert, *supra* note 300.

[306] *Drone-Based Inspections for Wind Turbine Blades*, *supra* note 301.

[307] *Id.*

[308] XCEL ENERGY, *supra* note 295.

methods of inspection has increased Xcel's efficiency and safety of inspection and maintenance operations.[309] Moreover, Xcel's enhanced efficiency has improved its response times, reduced the cost and disruption to customers, and provided a less intrusive method of inspection.[310] Thus, commercial UAVs not only offer advantages to energy companies' customers and communities, but their ability to improve safety and quickly detect defects necessarily reduces their risk of litigation.

C. THE AGRICULTURE INDUSTRY

Like the construction and energy industries, the agriculture industry is using commercial UAVs for various reasons, including to improve crop production,[311] to assist in "planning disaster relief and response services,"[312] and to provide accurate estimates of crop loss.[313]

> The adoption of modern technologies in agriculture, such as the use of drones or unmanned aerial vehicles (UAVs) can significantly enhance risk and damage assessments and revolutionize the way we prepare for and respond to disasters that affect the livelihoods of vulnerable farmers and fishers and . . . food security.[314]

Before planting crops, commercial UAVs can be used to "[a]ssess water conditions in fields," to determine whether drainage management is needed in certain areas of fields, and to "[a]ssess soil health."[315] During the crop growing season, UAVs can be used to "[d]etect plant stress," to assess plant health, population, size, and productivity, to estimate crop yield, to determine "optimal harvest timing," to identify invasive species and resistant weeds, to determine the appropriate levels of nitrogen fertilization, to "[o]ptimize water usage by monitoring drought stress at different growth stages," and to "[r]apidly assess storm damage to [quickly] settle claims."[316] Along the same lines, UAVs can be used to assess damage to farm-related infrastructure, such as

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[309] *Id.*

[310] *See id.*

[311] Gerard Sylvester, *E-agriculture in Action: Drones for Agriculture*, FOOD & AGRIC. ORG. OF THE UNITED NATIONS 1, 2 (2018), http://www.fao.org/3/I8494EN/i8494en.pdf.

[312] *Id.* at 4.

[313] *Id.*

[314] *Id.* at 3.

[315] *Drone Mapping and Analytics for Agriculture*, PRECISIONHAWK, https://www.precisionhawk.com/agriculture (last visited Aug. 3, 2020); *see also* Vikram Puri, Anand Nayyar & Linesh Raja, *Agriculture Drones: A Modern Breakthrough in Precision Agriculture*, J. STAT. & MGMT. SYS. 508, 509 (Nov. 16, 2017).

[316] *Drone Mapping and Analytics for Agriculture*, *supra* note 315; *see also* Puri, Nayyar & Raja, *supra* note 315, at 509.

fences, roofs, and access roads.[317] Thus, commercial UAVs allow farmers with hundreds, or even thousands, of acres of land to accurately inspect every inch of his or her field,[318] and in turn, more accurately and quickly settle claims related to their crops and farm-related infrastructure.[319]

VI. CONCLUSION

From militarization to sports broadcasting and wildfire fighting, UAVs have become one of the most beneficial technologies in today's society. So long as federal and (limited) state regulations are followed, commercial UAVs will provide a safer, more efficient way of doing business. Whether attempting to maintain client expectations on a construction project, identifying cell degradation in solar panels, or assessing crop damage from a weather event, UAV technology has the potential to change the ways in which companies transact business in order to prevent, or quickly settle, disputes.

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[317] *Drone Mapping and Analytics for Agriculture*, *supra* note 315. Additional benefits of UAV use in the agriculture industry include the ability to map the best areas for grazing, to count herds and trees, to identify newborn animals, and to identify damaged or diseased trees. *Id.*

[318] Puri, Nayyar & Raja, *supra* note 315, at 510.

[319] *Drone Mapping and Analytics for Agriculture*, *supra* note 315.