THE INTEGRATION OF UNMANNED AERIAL VEHICLES INTO THE NATIONAL AIRSPACE

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I. INTRODUCTION

The ongoing development and use of unmanned aerial vehicles (UAVs) illustrates well the observation that "[l]aw lags science; it does not lead it."[1] UAVs exemplify the modern information age, an era of computer automation, the Internet, high-definition imagery, and "smart"-technology. More can be done virtually and by remote control today than at any time in history, and the corresponding actual and potential savings of personnel and resources are tangible.[2] In aviation parlance, UAVs are the leading-edge of contemporary aeronautical science and engineering and a product of a century of manned flight experience. However, UAV operations have out-paced the law in that they are not sufficiently supported by a dedicated and

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1. *See* Rosen v. Ciba-Geigy Corp., 78 F.3d 316, 319 (7th Cir. 1996).

2. *See, e.g.*, Jack M. Beard, *Law and War in the Virtual Era*, 103 AM. J. INT'L L. 409, 412-13 (2009).

enforceable regime of rules, regulations, and standards respecting their integration into the national airspace.[3]

The Federal Aviation Administration (FAA) defines a UAV as an unmanned aircraft or "device that is used or intended to be used for flight in the air that has no onboard pilot. This includes all classes of airplanes, helicopters, airships, and translational lift aircraft that have no onboard pilot."[4] Unmanned aircraft are known by a host of names including remotely piloted vehicles (RPVs), drones, robot planes, and unmanned combat aerial vehicles, but do not include missiles and rockets.[5] So defined, UAVs serve myriad military missions, have commercial and civilian applications, and possess capabilities that are as varied as their designs.

Military uses include national defense, disaster response, homeland security and law enforcement,[6] remote sensing, and "ISR" missions (intelligence, surveillance, and reconnaissance).[7] Civilian applications include traffic surveillance, weather monitoring, communications relay, border management, maritime patrol,[8] crime prevention, forest fire monitoring, and

3. The Federal Aviation Administration defines and divides the national airspace into two categories of airspace or airspace areas: regulatory (Class A, B, C, D and E airspace areas, restricted and prohibited areas) and non-regulatory (military operations areas (MOAs), warning areas, alert areas, and controlled firing areas). Within these two categories, there are four types: controlled, uncontrolled, special use, and other airspace. The categories and types of airspace are dictated by the complexity or density of aircraft movements, the nature of the operations conducted within the airspace, the level of safety required, and the national and public interest. *See generally* FED. AVIATION ADMIN. AERONAUTICAL INFORMATION MANUAL, *available at* http://www faa.gov/air_traffic/publications/ATpubs/AIM/chap3toc htm (last visited Feb. 21, 2010).

4. FED. AVIATION ADMIN., AFS-400 UAS Policy 05-01, UNMANNED AIRCRAFT SYSTEMS OPERATIONS IN THE U.S. NATIONAL AIRSPACE SYSTEM—INTERIM OPERATIONAL APPROVAL GUIDANCE (2005) [hereinafter INTERIM OPERATIONAL GUIDELINES]. Broadly, federal law establishes three separate types of conveyances: vessels ("which provide transportation on water"), vehicles ("which provide transportation on land"), and aircraft ("which provide transportation [by] air"). *See* U.S. v. Reid, 206 F. Supp. 2d 132, 140 (D. Mass. 2002). In other words, contrary to popular usage, an "aircraft" is not a "vehicle" under law. *See id.*

5. *See* Graham Warwick & Bettina H. Chavanne, *Skin in the Game*, AVIATION WK. & SPACE TECH., Aug. 10, 2009, at 56. "Unmanned Aircraft Systems" or "UAS" arguably is more accurate terminology for unmanned aerial vehicles as the unmanned aerial *vehicle* is only the airframe component of a coordinated *system* of associated ground-based personnel and equipment, including flight crew, air traffic control, and so forth. *Id.*

6. The criminal trafficking of unmanned aerial vehicles and components has generated recent litigation. *See*, *e.g.*, U.S. v. Hanson, 613 F. Supp. 2d 85, 87 (D.D.C. 2009); U.S. v. Khan, 461 F.3d 477, 484 (4th Cir. 2006).

7. UAV intelligence and surveillance capabilities obviously raise important constitutional considerations vis-à-vis civil liberties and privacy rights. *See*, *e.g.*, Troy Roberts, *On the Radar: Government Unmanned Aerial Vehicles and Their Effect on Public Privacy Interests from Fourth Amendment Jurisprudence and Legislative Policy Perspectives*, 49 JURIMETRICS J. 491, 500 (2009); Paul McBride, Comment, *Beyond Orwell: The Application of Unmanned Aircraft Systems in Domestic Surveillance Operations*, 74 J. AIR L. & COM. 627, 639 (2009).

8. *See generally* Vasilios Tasikas, *Unmanned Aerial Vehicles and the Doctrine of Hot Pursuit: A New Era of Coast Guard Maritime Law Enforcement Operations*, 29 TUL. MAR. L.J. 59, 60 (2004).

drug interdiction. Similarly, in the commercial sector, UAVs can undertake tasks relating to fishery and agricultural management, freight, pipeline monitoring, aerial photography, and search and rescue. In doing so, UAVs optimize the political, business, and human costs of "dull, dirty, and dangerous" activities.

UAVs are dynamic. They are nano, micro, mini, short-range, and tactical medium- and high-altitude combat aircraft whose diverse platforms complement a functional versatility.[9] They are manufactured in all shapes and sizes, from hand-held devices that weigh a mere few ounces to the several-thousand pound hunter-killer machines like the Predator B and Northrop-Grumman Global Hawk. In terms of performance, UAVs can be indefatigable relative to manned operations. For example, the hand-launched Qinetiq Zephyr solar-powered UAV can lift a small communications payload above 40,000 feet and stay aloft for two weeks.[10] Some UAVs are even entirely autonomous.[11] Aware of such capabilities, various forecasters appraise the value of the emerging UAV market between $60-100 billion over ten years with a surge in the civil and commercial markets specifically.[12] Militarily, the U.S. Air Force is training more unmanned aircraft pilots than on-board pilots.[13]

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9. The number of unmanned aerial vehicles in the Department of Defense's inventory increased from 167 in 2002 to more than 6,000 in 2008. The proliferation and variety of unmanned aerial vehicles has been so pronounced that the federal government has researched in great detail the objective of achieving airframe commonality among military unmanned aerial systems. *See*, *e.g.*, U.S. GOV'T ACCOUNTABILITY OFFICE, GAO NO. GAO-09-520, DEFENSE ACQUISITIONS: OPPORTUNITIES EXIST TO ACHIEVE GREATER COMMONALITY AND EFFICIENCIES AMONG UNMANNED AIRCRAFT SYSTEMS (July 2009); U.S. GOV'T ACCOUNTABILITY OFFICE, GAO NO. GAO-09-326SP, DEFENSE ACQUISITIONS: ASSESSMENT OF SELECTED WEAPON PROGRAMS (Mar. 2009); U.S. GOV'T ACCOUNTABILITY OFFICE, GAO NO. GAO-09-175, UNMANNED AIRCRAFT SYSTEMS: ADDITIONAL ACTIONS NEEDED TO IMPROVE MANAGEMENT AND INTEGRATION OF DOD EFFORTS TO SUPPORT WARFIGHTER NEEDS (Nov. 2008); U.S. GOV'T ACCOUNTABILITY OFFICE, GAO NO. GAO-06-593, DEFENSE ACQUISITIONS: BETTER ACQUISITIONS STRATEGY NEEDED FOR SUCCESSFUL DEVELOPMENT OF THE ARMY'S WARRIOR UNMANNED AIRCRAFT SYSTEM (May 2006); U.S. GOV'T ACCOUNTABILITY OFFICE, GAO NO. GAO-06-610T, UNMANNED AIRCRAFT SYSTEMS: IMPROVED PLANNING AND ACQUISITION STRATEGIES CAN HELP ADDRESS OPERATIONAL CHALLENGES (Apr. 2006); U.S. GOV'T ACCOUNTABILITY OFFICE, GAO NO. GAO-05-395T, UNMANNED AERIAL VEHICLES: IMPROVED STRATEGIC AND ACQUISITION PLANNING CAN HELP ADDRESS EMERGING CHALLENGES (Mar. 2005).

10. Graham Warwick, *Autonomous Futures*, AVIATION WK. & SPACE TECH., June 8, 2009, at 46, 47.

11. *See, e.g.*, Stephen E. White, Note, *Brave New World: Neurowarfare and the Limits of International Humanitarian Law*, 41 CORNELL INT'L L.J. 177, 185 (2008) (discussing legal implications of ongoing efforts by the Defense Advance Research Projects Agency (DARPA) to develop neurologically controlled weapon systems).

12. Graham Warwick & Robert Wall, *Market Machinations*, AVIATION WK. & SPACE TECH., June 22, 2009, at 35.

13. *See* Warwick, *Autonomous Futures*, *supra* note 10, at 46; *see also* David A. Fulghum, *UAVs: What's Next*, AVIATION WK. & SPACE TECH., Aug. 17, 2009, at 20. Unmanned aerial vehicles may supplant space satellite technology as the government has worked to develop

While the path for UAV development in the military, civil, and commercial sectors domestically and internationally seems clear, the saying that "the sky's the limit" may literally be true as UAVs increasingly become part of the national airspace system (NAS). After all, the national airspace is already occupied by aircraft manned by general, commercial, and military interests, and it is not entirely clear whether, when, how, or if UAVs of every type can or should be incorporated into the busy NAS environment. Whether UAVs can be integrated into the national airspace without also posing a safety or national security issue is an open question.[14] As the FAA itself noted of UAVs:

> These devices may be as simple as a remotely controlled model aircraft used for recreational purposes or as complex as surveillance aircraft flying over hostile areas in warfare. They may be controlled either manually or through an autopilot using a data link to connect the pilot to the aircraft. They may perform a variety of public services: surveillance, collection of air samples to determine levels of pollution, or rescue and recovery missions in crisis situations. They range in size from wingspans of six inches to 246 feet; and can weigh from approximately four ounces to over 25,600 pounds. The one thing they have in common is that their numbers and uses are growing dramatically. In the United States alone, approximately 50 companies, universities, and government organizations are developing and producing some 155 unmanned aircraft designs. Regulatory standards need to be developed to enable current technology for unmanned aircraft to comply [with existing aviation regulations].[15]

The absence of a distinctive body of rules and regulations integrating UAV flight into the national airspace, coupled with an existing time-consuming certification process for UAV flight in the first place, is an impediment and constraint for present and future UAV development.

"HALE" UAVs, or high-altitude long-endurance machines to serve low earth orbit missions as part of the Environmental Research Aircraft and Sensor Technology (ERAST) project. *See* Dryden Flight Research Center, http://www nasa.gov/centers/dryden/news/FactSheets/FS-020-DFRC html (last visited Mar. 8, 2010). Moreover, unmanned vehicles are not limited to aviation missions as the Army and Navy themselves are developing unmanned ground and naval vessels. *See*, *e.g.*, J. Ricou Heaton, *Civilians at War: Reexamining the Status of Civilians Accompanying the Armed Forces*, 57 A.F. L. REV. 155, 163-68 (2005).

14. *See*, *e.g.*, Mark E. Peterson, *The UAV and the Current and Future Regulatory Construct for Integration into the National Airspace System*, 71 J. AIR L. & COM. 521, 524 (2006).

15. FED. AVIATION ADMIN., FAA 2006-25714, UNMANNED AIRCRAFT OPERATIONS IN THE NATIONAL AIRSPACE SYSTEM, *available at* http://www faa.gov/aircraft/air_cert/design_approvals/uas/reg/media/frnotice_uas.pdf [hereinafter FED. AVIATION ADMIN., NATIONAL AIRSPACE SYSTEM].

Current federal air regulations (FARs) did not anticipate operation of controlled unmanned aircraft in civil airspace. There is no specific part or definition under applicable law related to unmanned aircraft. The absence of absolute legal guidance with respect to the jurisdiction of UAV regulation, the definition of UAV, and the integration of UAVs in the national airspace prevents the optimum use of UAVs for the public benefit. Yet, given the risks of a ground impact or mid-air collision with other aircraft, the need for regulatory certainty respecting UAVs is an imminent issue deserving the attention of regulators, manufacturers, and operators alike.

This article reviews laws and policies applicable to UAV operations in the national airspace and calls for definite legal parameters for this emerging sector of aviation. Part II provides a brief background of the way in which the law has historically dealt with air and land rights relative to new and unprecedented developments in aviation. Part III explores the operative regulatory regime that exists today, evaluates its fitness in the UAV context, and introduces the development of UAV-related laws in foreign jurisdictions. Ultimately, there is nothing necessarily objectionable about having the law follow technology in terms of UAV development. That is, while policymakers should aggressively encourage UAV production and use in the civil, commercial, and military realms, they should approach the laws regulating UAV operations conservatively, integrating different UAV assets into the national airspace in-step with improvements in UAV technological reliability. At the same time, given the actual proliferation of UAVs in the commercial and military markets, the time for lawmakers to more directly address UAV integration into the NAS as a matter of law is now.

II. BACKGROUND: FROM BALLOONS TO BALLISTICS

Although UAVs have only recently attracted widespread attention—no doubt as a function of recent conflicts in Afghanistan, Iraq, and Kosovo—the history of unmanned aircraft dates back to the early 1920s. The United States tested, but never deployed, UAVs during World War I. Later, Joe Kennedy, Jr., the eldest brother of President John F. Kennedy and Senator Edward Kennedy, volunteered for and perished during a covert Navy mission called "Project Anvil" in World War II.[16] This mission was part of the U.S. Air Force's "Operation Aphrodite" in which a crew would fly a PB4Y-1 Liberator bomber laden with explosives, parachute out, and then

16. *See*, *e.g.*, A People at War, http://www.archives.gov/exhibits/a_people_at_war/war_in_europe/lt_joseph_kennedy_jr html (last visited Feb. 21, 2009).

direct the bomber by radio control to its target.[17] Abroad, during World War II, Germany employed the V-1 "flying bomb" and set the stage for post-war UAV programs, which found particular use during the Vietnam War, when the United States used the AQM-34 Firebee in a surveillance role.[18] Today, military and non-military interests have found other roles for UAVs that require use of the NAS and not merely the airspace over battle fields. Thus, while UAVs are not a totally new phenomenon,[19] their exponentially increased use in the modern era does present a novel issue: how to integrate UAV operations into the NAS.

The issue of integrating UAVs into the national airspace harkens back to the earliest days of manned flight when jurists first were confronted with the challenge of harmonizing ground based rights with air rights. Specifically, well before air traffic control regulations and practices existed, courts were left to deal with manned air operations by reference to the legal concept of trespass. For example, in arguably the first aviation decision of record, *Guille v. Swan*,[20] a property owner in the early 1800s sued after the operator of an air balloon crash-landed into his garden in New York City.[21] "When the balloon descended [the balloonist called for assistance and] more than two hundred persons broke into [the] garden through the fences, and came onto the premises; beating down vegetables and flowers."[22]

Ultimately, the property owner successfully sued for money damages.[23] The *Guille* court found the balloonist strictly liable for trespass:

> [A]scending in a balloon is [not] an unlawful act . . . ; but, it is certain, that the aeronaut has no control over its motion horizontally; he is at the sport of the winds and is to descend when and how he can; his reaching the earth is a matter of hazard. He did descend on the premises of the plaintiff below, at a short distance from the place where he ascended. Now, if his descent, under such circumstances, would, ordinarily and naturally, draw a crowd of people about him, either from curiosity, or for the purpose of

17. *Id.*

18. *See generally* Lexi Krock, Spies that Fly, http://www.pbs.org/wgbh/nova/spiesfly/uavs html (last visited Feb. 21, 2010).

19. For a discussion of the early history of unmanned aerial vehicles, *see* Richard A. Best, *Intelligence Technology in the Post-Cold War: The Role of Unmanned Aerial Vehicles (UAVs)* (1993); Jim Garamon, *From U.S. Civil War to Afghanistan: A Short History of UAVs,* AM. FORCES INFORMATION SVCS., Apr. 16, 2002, *available at* http://www.defense.gov/news/newsarticle.aspx?id=44164; and LAURENCE R. NEWCOME, UNMANNED AVIATION: A BRIEF HISTORY OF UNMANNED AERIAL VEHICLES 1-9 (2004).

20. 19 Johns. 381 (N.Y. Sup. Ct. 1822).

21. *Guille*, 19 Johns. at 381.

22. *Id.*

23. *Id.*

> rescuing him from a perilous situation; all this he ought to have foreseen, and must be responsible for.[24]

Guille simply reflected an early view of aviation—whether by balloon or something else—as an ultrahazardous activity.[25]

Internationally, nearly eighty years after the *Guille* decision, Russia's Foreign Minister Mikhail Nikolayevich Muravyov convened the Peace Conference at The Hague, Netherlands, in 1899. There, international interests negotiated and concluded a treaty that expressed the same sort of concerns about accuracy and reliability that accompany the issue of UAV operation in the NAS today. Specifically, the Hague Convention of 1899 established an initial international legal framework regarding war and, with respect to aviation military operations, imposed a moratorium on aerial platform bombing by banning the launch of projectiles and explosives from air balloons.[26] More specifically, the American delegation to the conference reported:

> [t]he [military subdivision] Sub-Committee [of the First Peace Conference at The Hague] first voted a perpetual prohibition of the use of balloons or similar new machines for throwing projectiles or explosives. In the full Committee, this subject was brought up for reconsideration by the United States Delegate and the prohibition was, by unanimous vote, limited to cover a period of five years

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24. *Id.* at 382. More than a century later, the American Law Institute reformulated the rule expressed in *Guille*, that the doctrine of strict liability controls legal disputes concerning injuries caused by aircraft to persons and things on land:

> If physical harm to land or to persons or chattels on the ground is caused by the ascent, descent or flight of aircraft, or by the dropping or falling of an object from the aircraft,
>
> (a) the operator of the aircraft is subject to liability for the harm, even though he has exercised the utmost care to prevent it, and
>
> (b) the owner of the aircraft is subject to similar liability if he has authorized or permitted the operation.

RESTATEMENT (SECOND) OF TORTS § 520A (1977). Some courts have applied a comparative negligence standard to the issue of whether owners and operators flying aircraft should be strictly liable for ground damage caused by operation of aircraft. *E.g.*, Crosby v. Cox Aircraft Co. of Washington, 746 P.2d 1198, 1202 (Wash. 1987).

25. *Compare* Rochester Gas & Elec. Corp. v. Dunlop, 266 N.Y.S. 469, 473 (N.Y. Co. Ct. 1933) (finding strict liability for trespass and property damaged caused by airplane crash) *with* Crist v. Civil Air Patrol, 278 N.Y.S.2d 430, 433-34 (N.Y. App. Div. 1967) (declining application of the strict liability doctrine of *res ipsa loquitur* in absence of showing of intent to crash airplane: "Technological advances and development, and the experiences of the last two decades have dissipated the universal early fears that flying was an ultrahazardous occupation. The application of the trespass theory advanced in the *Dunlop* case appears to be based to some extent on a recognition of such earlier fear.").

26. DECLARATION TO PROHIBIT FOR THE TERM OF FIVE YEARS THE LAUNCHING OF PROJECTILES AND EXPLOSIVES FROM BALLOONS, AND OTHER NEW METHODS OF A SIMILAR NATURE, July 29, 1899, 32 Stat. 1839, *available at* http://avalon.law.yale.edu/19th_century/hague994.asp.

> only. The action taken was for humanitarian reasons alone, and was founded upon the opinion that balloons, as they now exist, form such an uncertain means of injury that they cannot be used with any accuracy; that the persons or objects injured by throwing explosives from them may be entirely disconnected from any conflict which may be in process, and such that their injury or destruction would be of no practical advantage to the party making use of the machines. The limitation of the interdiction of five years' operation preserves liberty of action under changed circumstances which may be produced by the progress of invention.[27]

Meanwhile, as air travel became more routine within the United States, legislators designed a domestic aviation law framework that receded from the ancient doctrine of *cujus est solum ejus est usque ad coelum*, a common law maxim that individual ownership of land extended upward to the periphery of the universe. At the dawn of commercial aviation, Congress enacted the Air Commerce Act of 1926, as amended by the Civil Aeronautics Act of 1938, confirming that the United States has "to the exclusion of all foreign nations, complete sovereignty of the airspace" over the country while citizens had "a public right of freedom of transit in air commerce through the navigable air space of the United States."[28] Congress then defined navigable air space as "airspace above the minimum safe altitudes of flight prescribed by the [Civil Aeronautics Authority]" and Congress provided that "such navigable airspace shall be subject to a public right of freedom of interstate and foreign air navigation."[29] At the conclusion of World War II, the Supreme Court of the United States recognized that aviation ushered in a new era of property rights:

> [The] doctrine [of *cujus est solum ejus est usque ad coelum*] has no place in the modern world. The air is a public highway, as Congress has declared. Were that not true, every transcontinental flight would subject the operator to countless trespass suits. Common sense revolts at the idea. To recognize such private claims to the airspace would clog these highways, seriously interfere with their control and development in the public interest, and transfer

27. PEACE CONFERENCE AT THE HAGUE 1899: REPORT OF CAPTAIN CROZIER TO THE COMMISSION OF THE UNITED STATES OF AMERICA TO THE INTERNATIONAL CONFERENCE AT THE HAGUE REGARDING THE WORK OF THE FIRST COMMITTEE OF THE CONFERENCE AND ITS SUBCOMMITTEE (1899), *available at* http://avalon.law.yale.edu/19th_century/hag99-05.asp (last visited Mar. 8, 2010).

28. Air Commerce Act of 1926, Pub. L. No. 69-254, 44 Stat. 568, 572.

29. *Id*. at 574.

> into private ownership that to which only the public has a just claim.[30]

Fast forwarding to the modern era, a time when ownership of the NAS is more defined and highly regulated, nobody seriously contends that UAVs should be excluded from the aviation highway known as the national airspace. But formulating laws that allow UAVs to operate safely alongside other aircraft traffic invites differing views as a practical and legal matter.

III. DISCUSSION

In 2009, approximately 20,000 UAV flights occurred in civilian airspace, accumulating over 2,500 hours, and representing a tripling of UAV operations since 2007.[31] Today, military and civilian interests are employing UAVs more regularly in ways that require sharing airspace with other assets in aviation commerce. One study prepared for the Secretary of Defense concluded that, as the United States military particularly includes UAVs into its force structure, the Department of Defense (DoD) "has an urgent need to allow UAVs unencumbered access to the National Airspace System . . . outside of restricted areas (airbases and military operating areas), here in the United States and around the world."[32] However, as UAV inventory and traffic increases within the national airspace, so do the chances of accidents, including mid-air collision.

Given the need for widespread access for UAVs in the national airspace and the concomitant risk of collision with passenger or other aircraft, federal aviation authorities are rapidly facing serious safety concerns.[33] The FAA Administrator framed the issue as a matter of public relations:

> We know the headlines following the [sightseeing] helicopter accident over the Hudson [River in New York in late 2009]. That was

30. U.S. v. Causby, 328 U.S. 256, 261 (1946).

31. J. Randolph Babbitt, Administrator, Fed. Aviation Admin, Remarks to AIA: Unmanned Aircraft Systems: Safety Must Come First (Nov. 18, 2009), *available at* http://www faa.gov/news/speeches/news_story.cfm?newsId=10964.

32. DEFENSE SCIENCE BD. STUDY, UNMANNED AERIAL VEHICLES AND UNINHABITED COMBAT AERIAL VEHICLES 18 (2004), *available at* http://www fas.org/irp/agency/dod/dsb/uav.pdf.

33. *See* ROLAND E. WEIBEL & R. JOHN HANSMAN, SAFETY CONSIDERATIONS FOR OPERATION OF UNMANNED AERIAL VEHICLES IN THE NATIONAL AIRSPACE SYSTEM 36 (2005), *available at* http://dspace.mit.edu/bitstream/handle/1721.1/34912/Weibel%20-%20ICAT%20Report%20-%20UAV%20Safety.pdf?sequence=1. The MIT International Center for Air Transportation correlated the chance of a collision between a UAV and another target as a function of the mass or size of the UAV, suggesting the accident risk for a UAV increases in direct proportion with its mass, in certain areas. *Id.*; MIT INT'L CENTER FOR AIR TRANSP., SAFETY CONSIDERATIONS FOR OPERATION OF SMALL UNMANNED AERIAL VEHICLES IN CIVIL AIRSPACE, Oct. 23, 2003.

> followed by two Congressional Hearings and calls to immediately shut down all traffic over the Hudson or sharply curtail these operations.
>
> Now can you imagine if one of those aircraft had been an unmanned system? With the headline: "Unmanned Robot plane crash kills 9." How do you think Congress would react to that headline . . . ?[34]

In fact, the danger posed by a UAV mishap is not a hypothetical matter and informs the lethargy with which regulators have acted to integrate UAVs into the national airspace fully.

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34. Babbitt, *supra* note 31. On April 25, 2006, a General Atomics Aeronautical Systems-built MQ-9 Predator B owned by the U.S. Customs and Border Protection Agency (CBP) crashed near the airport in Nogales, Arizona. It represented the first occasion for the National Transportation Safety Board (NTSB) to investigate an accident of an unmanned aerial vehicle. The NTSB found:

> The flight was being flown from a ground control station (GCS), which contained two nearly identical control consoles: PPO-1 and PPO-2. Normally, a certified pilot controls the UA from PPO-1, and the camera payload operator (typically a U.S. Border Patrol agent) controls the camera, which is mounted on the UA, from PPO-2. Although the aircraft control levers (flaps, condition lever, throttle, and speed lever) on PPO-1 and PPO-2 appear identical, they may have different functions depending on which console controls the UA.
>
> The investigation revealed a series of computer lockups had occurred since the CBP UAS began operating. Nine lockups occurred in a 3-month period before the accident, including 2 on the day of the accident before takeoff and another on April 19, 2006, 6 days before the accident. Troubleshooting before and after the accident did not determine the cause of the lockups. Neither the CBP nor its contractors had a documented maintenance program that ensured that maintenance tasks were performed correctly and that comprehensive root-cause analyses and corrective action procedures were required when failures, such as console lockups, occurred repeatedly.
>
> Review of the CBP's training records showed that the accident pilot had recently transitioned from flying the Predator A to flying the Predator B and had only 27 hours of Predator B flight time. According to the CBP, the pilot was given verbal approval to fly its Predator B with the caveat that the pilot's instructor would be present in the GCS when the pilot was flying. This verbal approval was not standard practice for the CBP. The instructor pilot was in another building on the airport and did not enter the GCS until after it was shut down and the UA entered the lost-link procedure.
>
> The investigation also revealed that the CBP was providing a minimal amount of operational oversight for the UAS program at the time of the accident.
>
> The National Transportation Safety Board determines the probable cause(s) of this accident as follows:
>
> > The pilot's failure to use checklist procedures when switching operational control from PPO-1 to PPO-2, which resulted in the fuel valve inadvertently being shut off and the subsequent total loss of engine power, and lack of a flight instructor in the GCS, as required by the CBP's approval to allow the pilot to fly the Predator B. Factors associated with the accident were repeated and unresolved console lockups, inadequate maintenance procedures performed by the manufacturer, and the operator's inadequate surveillance of the UAS program.

NAT'L TRANSP. SAFETY BD., NTSB IDENTIFICATION: CHI06MA121, 2007, *available at* http://www ntsb.gov/ntsb/brief.asp?ev_id=20060509X00531&key=1.

UAV mishap rates and their proclivity to crash are relatively high. Empirically, UAVs are less reliable than manned aircraft over significantly fewer flight hours. Where large airliners have a mishap rate of 0.01 per 100,000 flight hours, UAV accidents have occurred at much higher frequencies.[35] For example, 334 mishaps have occurred with the Navy and Marines' "Pioneer" UAV.[36] Power and propulsion related failures accounted for 37% of UAV mishaps, while flight control failures and human error account for 25% and 17% of UAV accidents, respectively.[37] Unsurprisingly then, the strict current federal regulations and policy that today control the time, place, and equipment used for UAV operation reflect a legitimate concern about UAV safety.

To the extent lawmakers should craft and enact discrete rules or policies integrating UAVs into the NAS in light of documented mishaps, many outstanding questions remain. Among the questions to be resolved in advance of UAV integration into the NAS are what on-board safety equipment a UAV possesses and whether the aircraft has a high visibility paint scheme enabling other pilots to see and avoid it and observers to obtain and track it. Moreover, current law does not address what happens when the communications link between a UAV and ground resources fails, or whether a UAV must have position and anti-collision lights, and if so, whether procedures must exist if the lights are inoperative on a UAV operating under applicable FARs for manned aircraft. With respect to air traffic control, the law does not express how a UAV controller must communicate with other airspace users or even what minimum communications equipment must exist in UAV operations.

The lack of a concrete regulatory framework in these regards and the consequent lack of definitive operational instructions are impediments to UAV manufacturers and operators. Indeed, the lack of regulatory oversight diminishes the marketability of UAVs and blunts incentives to enter the UAV market because the issue of insurance coverage for liability for UAV operations remains unaddressed. That said, as detailed below, a process does exist for certifying and authorizing the operations of most UAVs under

35. *See* DEFENSE SCIENCE BD. STUDY, *supra* note 32, at 40; *see also* Nathan Hodge, *Jumper: Military Must Reorganize UAV Efforts*, DEFENSE DAILY, Apr. 29, 2005, at 7 (discussing problematic UAV operations in Iraq).

36. DEFENSE SCIENCE BD. STUDY, *supra* note 32, at 41.

37. *Id.* Unresolved issues that may contribute to UAV human factors include how pilots or air traffic controllers manage the lag in communication with the UAV and the degree to which UAV pilots otherwise obtain and maintain the training, skill set, and medical qualifications for UAV operation. *See, e.g.*, JASON S. MCCARLEY & CHRISTOPHER D. WICKENS, HUMAN FACTORS IMPLICATIONS OF UAVS IN THE NATIONAL AIRSPACE 10-11 (2005), *available at* http://www humanfactors.illinois.edu/Reports&PapersPDFs/TechReport/05-05.pdf.

current regulations, even if the answers to the foregoing overriding questions remain wanting as a matter of law.

A. EXISTING REGULATORY GUIDANCE

The fact that UAVs introduce a unique element into the national airspace and present the risk of collision with other aircraft and other civil airspace users is not new. Dating back to June 1981, the FAA published an advisory circular (AC) entitled "Notice of Policy for Unmanned Aircraft Systems" to highlight the development and growth of recreational UAV users and to encourage voluntary compliance with then-formulated guidelines for the safe operation of remotely controlled aircraft, also called "model" airplanes.[38] That AC encouraged users to operate aircraft less than 400 feet above ground level and not closer than three miles from airports.[39] More recently, to mitigate the risk of an accident or incident between UAVs and other traffic in the NAS, the FAA has authored a series of further guidelines to determine if UAVs may be allowed to conduct flight operations in the national airspace.

Specifically, the FAA established a dedicated Unmanned Aircraft Program Office in December 2005 to serve as the organization's focal point for unmanned aviation policies and standards. Through that office, the FAA currently requires UAV operators to demonstrate that flight operations will be conducted at an acceptable level of safety and that injury to persons or property along the flight path is "extremely improbable."[40] Upon such a showing, the FAA may issue a Certificate of Authorization or Waiver (COA) that allows public UAV flight in the national airspace. Private-sector civil entities must apply for special airworthiness certificates; however, no process is currently available for authorizing commercial UAV operations.[41]

The special showing that the FAA now requires of UAV operations is justified on the basis that flights in civil airspace are generally governed by particular right-of-way rules that evade traditional application in the UAV context. For example, Title 14 of the Code of Federal Regulations provides regulation with respect to aircraft other than those operating on water:

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38. FED. AVIATION ADMIN., AC 91-57, MODEL AIRCRAFT OPERATING STANDARDS (1981); *see also* FED. AVIATION ADMIN., NATIONAL AIRSPACE SYSTEM, *supra* note 15, at 5.

39. FED. AVIATION ADMIN., AC 91-57, *supra* note 38, ¶ 3.c.

40. FED. AVIATION ADMIN., NATIONAL AIRSPACE SYSTEM, *supra* note 15, at 3.

41. The FAA provided the latest regulatory guidance respecting UAV certification and operation in 2008. FED. AVIATION ADMIN., UNMANNED AIRCRAFT SYSTEMS OPERATIONS IN THE U.S. NATIONAL AIRSPACE SYSTEM—INTERIM APPROVAL GUIDANCE 08-01 (2008) [hereinafter FED. AVIATION ADMIN., UAS OPERATIONS].

(b) *General.* When weather conditions permit, regardless of whether an operation is conducted under instrument flight rules or visual flight rules, vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft. When a rule of this section gives another aircraft the right-of-way, the pilot shall give way to that aircraft and may not pass over, under, or ahead of it unless well clear.

(c) *In distress.* An aircraft in distress has the right-of-way over all other air traffic.

(d) *Converging.* When aircraft of the same category are converging at approximately the same altitude (except head-on, or nearly so), the aircraft to the other's right has the right-of-way. If the aircraft are of different categories—

(1) A balloon has the right-of-way over any other category of aircraft;

(2) A glider has the right-of-way over an airship, powered parachute, weight-shift-control aircraft, airplane, or rotorcraft;

(3) An airship has the right-of-way over a powered parachute, weight-shift-control aircraft, airplane, or rotorcraft.

However, an aircraft towing or refueling other aircraft has the right-of-way over all other engine-driven aircraft.

(e) *Approaching head-on.* When aircraft are approaching each other head-on, or nearly so, each pilot of each aircraft shall alter course to the right.

(f) *Overtaking.* Each aircraft that is being overtaken has the right-of-way and each pilot of an overtaking aircraft shall alter course to the right to pass well clear.

(g) *Landing.* Aircraft, while on final approach to land or while landing, have the right-of-way over other aircraft in flight or operating on the surface, except that they shall not take advantage of this rule to force an aircraft off the runway surface which has already landed and is attempting to make way for an aircraft on final approach. When two or more aircraft are approaching an airport for the purpose of landing, the aircraft at the lower altitude has the right-of-way, but it shall not take advantage of this rule to cut in

> front of another which is on final approach to land or to overtake that aircraft.[42]

Applying these regulations, the FAA has acknowledged "there would be no UAV flights in civil airspace" whatsoever if it applied existing detect, "see-and-avoid" requirements strictly or vigorously.[43] Indeed, in light of the tension between increased UAV operations and existent "see-and-avoid" regulations, the FAA has expressed concern about the interaction of UAVs and "non-cooperative" aircraft and other airborne operations that are not reliably identified by RADAR, including balloons, gliders, parachutists, and the like.[44]

While UAVs generally may be equipped with onboard cameras and sensors to observe targets on the ground, the FAA has reasoned that such mechanisms are of little use in detecting airborne operations for the purpose of regulatory compliance and, accordingly, cannot be considered as the sole means of mitigation in "see-and-avoid" assessment.[45] Consequently, the FAA COA process stands alone as the means of validating that a UAV operator will see and avoid other air traffic in airspace through various technologies, including GPS navigation, automatic dependent surveillance, traffic alert and collision avoidance, Mode S secondary surveillance radar, and an identify friend/foe transponder. That said, to the extent special types of RADAR or other sensors are utilized to mitigate the risk of mid-air collision, the FAA also requires UAV applicants to demonstrate that "[(i)] non-cooperative aircraft, including targets with low-RADAR reflectivity, such as gliders and balloons, can be consistently identified at all operational altitudes and ranges, and [(ii)] collision between those targets and [UAVs] is highly unlikely."[46]

Given the seeming inapplicability of "see-and-avoid" regulations to UAVs, when government agencies—including local law enforcement and state universities—want to fly a UAV in civil airspace, the FAA evaluates a COA request upon the following principles:[47]

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42. 14 C.F.R. § 91.113 (2009).

43. INTERIM OPERATIONAL GUIDELINES, *supra* note 4, ¶ 4; *see also* Graham Warwick, *Sharing Airspace*, AVIATION WK. & SPACE TECH., June 8, 2009, at 51 (reporting development of onboard sense-and-avoid platform called multiple intruder autonomous avoidance (MIAA) for testing in fiscal year 2010).

44. INTERIM OPERATIONAL GUIDELINES, *supra* note 4, ¶ 4. Non-cooperative aircraft are not tracked by air traffic or are aircraft that do not have an electronic means of identification aboard, such as a transponder.

45. *Id.* ¶ 6.15.

46. *Id.* ¶ 4.

47. FED. AVIATION ADMIN., UNMANNED AIRCRAFT SYSTEMS (UAS), FACT SHEET (2009), *available at* http://www faa.gov/news/fact_sheets/news_story.cfm?newsId=6287 [hereinafter UNMANNED AIRCRAFT SYSTEMS, FACT SHEET].

- The COA authorizes an operator to use defined airspace and includes special provisions unique to each operation. For instance, a COA may include a requirement to operate only under Visual Flight Rules ("VFR") and during daylight hours. Most are issued for a specified time (up to one year, in some cases);
- Most, if not all, COAs require coordination with an appropriate air traffic control facility and require the UAV to have a transponder able to operate in standard air traffic control mode with automatic altitude reporting; and
- To make sure the UAV will not interfere with other aircraft, a ground observer or an accompanying "chase" aircraft must maintain visual contact with the [UAV].[48]

Within these evaluative constraints, as of late 2009, the FAA issued 89 COAs, with 188 applications pending.[49] Still, proceeding with UAV operations on the basis of case-by-case approvals is not optimal.

B. CURRENT FAA POLICY FOR PUBLIC, CIVIL, AND MODEL UAVS

Whether a UAV is a public, civil, or model aircraft, current FAA policy for all UAV operations is that "no person may operate a UAS in the National Airspace System without specific authority. For UAS operating as public aircraft the authority is the [operative Certificate of Waiver or Authorization], for UAS operating as civil aircraft the authority is special airworthiness certificates, and for model aircraft the authority is AC 91-57."[50]

First, government use of UAVs best illustrates the "public" role of UAVs. For example, the United States DoD exercises the most common

48. *Id.* Operators of unmanned aircraft (UA) bear visual observer responsibilities, as follows:

> [i]n general, [UAV operators] should yield the right of way to any manned aircraft. The task of the observer is to provide the pilot of the UA with instructions to steer the UA clear of any potential collision with other [aircraft]. Visual observer duties require continuous visual contact with the UA at all times. At no time will the visual observer permit the UA to operate outside the line-of-sight to ensure that any required maneuvering information can be reliably provided to the [pilot-in-command]. At no time will visual observers conduct their duties more than one mile laterally or 3000 feet vertically from the UA. When using aids to vision, such as binoculars, field glasses, or telephoto television, visual observers must use caution to ensure that the UA remains within one mile laterally and 3000 feet vertically of the observer.

INTERIM OPERATIONAL GUIDELINES, *supra* note 4, ¶ 6.20.

49. UNMANNED AIRCRAFT SYSTEMS, FACT SHEET, *supra* note 47. The FAA issued 102 COAs in 2006, 85 in 2007, and 164 in 2008. *Id.*

50. FED. AVIATION ADMIN., NATIONAL AIRSPACE SYSTEM, *supra* note 15, at 5.

public use of UAVs, employing more than 700 UAVs for surveillance and weapon delivery in Iraq alone.[51] Other federal agencies, including Customs and Border Protection, have also applied UAVs to patrol the United States border, and UAVs in the future may provide first responder reports of damage due to weather or other natural disasters.[52] The FAA regulates the demand for public use of unmanned aircraft operations through a memorandum entitled "Unmanned Aircraft Systems Operations in the U.S. National Airspace System-Interim Operations Guidance (UAS Policy 05-01)."[53] That policy defines a process of evaluating applications for COAs for unmanned aircraft to operate in the national airspace.[54] The FAA has explained the underpinnings of its policy as arising from a concern that:

> unmanned aircraft operations [not only] might interfere with commercial and general aviation aircraft operations, but [also] that they could also pose a safety problem for other airborne vehicles, and persons or property on the ground. The FAA guidance supports unmanned aircraft flight activity that can be conducted at an acceptable level of safety.[55]

By requiring operators to demonstrate the airworthiness of their UAV through FAA certification or a Department of Defense airworthiness statement or other approved means, the FAA's stated intention is to promote or ensure this "acceptable level of safety."[56] Applicants for UAV operation are thus required not only to comply with appropriate cloud and terrain clearances, but also "to demonstrate that a collision with another aircraft or other airspace user is extremely improbable."[57]

In addition to being regulated by the certification and approval process, public UAV operational safety also turns on functional notions of pilot-in-command (PIC) and "observer." The PIC is "the person in control of, and responsible for, the [UAV]."[58] Under the most current FAA order governing airworthiness certification of unmanned aircraft systems, all UAV flight operations must have a designated PIC, who must perform crew duties for only one UAV at a time and bear responsibility and accountability for each

51. *Id*. at 2.
52. *Id*.
53. *See* INTERIM OPERATIONAL GUIDELINES, *supra* note 4.
54. *Id*.
55. FED. AVIATION ADMIN., NATIONAL AIRSPACE SYSTEM, *supra* note 15, at 2-3.
56. *Id*. at 3.
57. *Id*.
58. *Id*.

flight conducted.[59] The PIC is held to the FAA's UAV Interim Operations Guidance policy and is also obligated to meet minimum qualification and currency requirements established by the FAA.[60] Operationally, the PIC of a UAV "must avoid densely populated areas . . . and exercise increased vigilance within or in the vicinity of published airway boundaries."[61] Moreover, the UAV PIC is responsible for the safety of the aircraft and all persons and property along the flight path, "including collision avoidance and the safety of persons and property in the air and on the ground."[62]

Similarly, public UAVs must be supported by an observer who undertakes "to observe the activity of the unmanned aircraft and surrounding airspace, either through line-of-sight on the ground or in the air by means of a chase aircraft."[63] Both the PIC and observer must (i) maintain "direct communication" at all times, and UAVs must meet certain specifications:

> [(ii) fly] above 18,000 feet, [(iii)] be conducted under Instrument Flight Rules [(IFR)] on an IFR flight plan, [(iv)] obtain [air traffic control] clearance, [(v)] be equipped with at least a Mode C transponder (preferably a Mode S), operating . . . lights and/or collision avoidance lights, and [(vi)] maintain communication between the PIC and Air Traffic Control.[64]

The observer, in turn, is prohibited from permitting the UAV to operate beyond line-of-sight and obligated to provide the PIC with instructions to maneuver clear of any potential collision with other traffic.[65] While an observer may be positioned in a chase aircraft, the chase aircraft must maintain a reasonable proximity and position itself relative to the UAV, to reduce the hazard of a collision.[66] Additionally, when an observer is located in a chase aircraft, concurrent duty as a pilot of the chase aircraft is disallowed and the observer's duties must be dedicated strictly to the task of

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59. FED. AVIATION ADMIN., Order 8130.34 AIRWORTHINESS CERTIFICATION OF UNMANNED AIRCRAFT SYSTEMS A-4 (2008) [hereinafter FED. AVIATION ADMIN., AIRWORTHINESS CERTIFICATION].

60. *Id*. at A-5; *see also* 14 C.F.R. Pt. 61, 63, 65, 67 (2009).

61. FED. AVIATION ADMIN., AIRWORTHINESS CERTIFICATION, *supra* note 59, at A-4; *see also* 14 C.F.R.§ 91.319 (2009).

62. FED. AVIATION ADMIN., AIRWORTHINESS CERTIFICATION, *supra* note 59, at A-4.

63. FED. AVIATION ADMIN., NATIONAL AIRSPACE SYSTEM, *supra* note 15, at 3. In general, "the pilot or observer must be, in most cases, within [one] mile laterally and 3,000 feet vertically of the unmanned [aerial vehicle]." *Id.*

64. *Id*. Unmanned aircraft below 18,000 feet have similar requirements, except that if operators choose to operate other than an instrument flight rules flight plan, they may be required to pre-coordinate with air traffic control. *Id.*

65. *Id*. at A-6.

66. *Id*.; *see also* 14 C.F.R. § 91.111 (2009).

observation, including ongoing scanning of the airspace for other aircraft that pose a potential risk.[67]

Next, UAVs in the civil arena, like UAVs in the public sector, are governed by particular FAA directives. Current FAA policy requires operators of civil UAVs to obtain an FAA airworthiness certificate the same as any other type of aircraft.[68] But the FAA is issuing special airworthiness certificates in only the experimental category, meaning that particular limitations apply to the UAV's operation.[69] UAV operators with experimental certificates may not be hired for compensation, but can employ a UAV for purposes of research and development, marketing surveys, or crew training.[70] Under existing regulations, moreover, an application must state the intended use for the UAV and provide sufficient information to satisfy the FAA that the aircraft can be operated safely.[71] Applicants are subject to an on-site review of the UAV system and open to a request to demonstrate the area of operation.[72] Civil UAV operators also must supply the FAA with the time or number of flights, a description of the areas over which the aircraft would operate, and drawings or detailed photographs of the aircraft.[73]

Another method of justifying UAV operations is through the FAA's Model Operating Standards, published in 1981, which provide guidance to people interested in flying model aircraft as a hobby or for recreational use. In addition to encouraging operators to exercise good judgment in avoiding danger to persons on the ground or other aircraft, the FAA suggested that users pay careful attention to the site selected for UAV activities.[74] The FAA also expressed its expectation that hobbyists operate recreational model aircraft within visual line-of-sight and outside the vicinity of spectators until such time as the model aircraft was tested and deemed airworthy.[75] Recently, some UAV operators have used these recommendations with respect to UAVs that fall outside of the model or recreational category. Accordingly, the FAA clarified that it "recognizes that people and companies other than modelers might be flying UAS with the mistaken understanding that they are legally operating under the authority of the

67. FED. AVIATION ADMIN., AIRWORTHINESS CERTIFICATION, *supra* note 59, at A-6.
68. FED. AVIATION ADMIN., NATIONAL AIRSPACE SYSTEM, *supra* note 15, at 4.
69. *Id.*
70. *Id.*
71. *Id.; see also* 14 C.F.R. §§ 21.191, 21.193, 21.195 (2009).
72. FED. AVIATION ADMIN., NATIONAL AIRSPACE SYSTEM, *supra* note 15, at 4.
73. *Id.*
74. FED. AVIATION ADMIN., AC 91-57, MODEL AIRCRAFT OPERATING STANDARDS, *supra* note 38, ¶ 3(a). Noise sensitive areas might include parks, schools, hospitals, and churches.
75. *Id.* ¶ 3(b).

[Model Operating Standards;] . . . [such standards only apply] to modelers and [not] persons or companies for business purposes."[76]

C. THE MILITARY ROADMAP

In evaluating integration of UAVs into the national airspace, UAV military policy is instructive, given the prevalent use of UAVs by the armed services. Currently, the DoD relies upon FAA Order 7610.4 Special Military Operations to obtain approval to fly UAVs in the national airspace.[77] Because it can take up to two months to obtain the relevant COA for a particular mission, the DoD desires a "file and fly" plan by the end of 2012 for appropriately equipped UAVs that feature equivalent level of safety (ELOS) to aircraft with a pilot onboard.[78] Moreover, the DoD has identified homeland defense and civil authority roles for UAVs that would require routine access to the national airspace over land and water. To reach this objective, the DoD and the FAA are working collaboratively to establish an air traffic regulatory infrastructure for integrating military UAVs into the national airspace.[79] The government is specifically focused on traffic management of domestic flight operations. To increase its odds of success, the DoD's plan for UAV integration is guided by several precepts:

> *Do no harm.* Avoid new initiatives, *e.g.*, enacting regulations for the military user that would adversely impact the Military Departments' right to self-certify aircraft or aircrews, ATC practices or procedures, or manned aviation [concept of operations] or [tactics, techniques, and procedures] or that would unnecessarily restrict civilian or commercial flights. Where feasible, leave "hooks" in place to facilitate the adaptation of these regulations for civil use. This also applies to recognizing that "one size does NOT fit all" when it comes to establishing regulations for the wide range in size and performance of DoD UASs.
>
> *Conform rather than create.* Apply the existing Title 14 Code of Federal Regulations . . . to also cover unmanned aviation and avoid the creation of dedicated UAS regulations *as much as*

76. FED. AVIATION ADMIN., NATIONAL AIRSPACE SYSTEM, *supra* note 15, at 5-6.

77. *See also* DEP'T OF DEFENSE, UNMANNED SYSTEMS INTEGRATED ROADMAP FY 2009-2034, at 103 (2009), *available at* http://www.acq.osd mil/uas/docs/UMSIntegratedRoadmap2009.pdf (last visited Mar. 8, 2010).

78. DEP'T OF DEFENSE, UNMANNED SYSTEMS INTEGRATED ROADMAP 2007-2034 103 (2007) [hereinafter DOD, UNMANNED SYSTEMS ROADMAP]. As an interim step, the Air Force obtained approval from the FAA for a Global Hawk National COA, shortening the approval time to fly to more than five days, albeit only for domestic operations in restricted areas. *Id.*

79. *Id.*

> *possible*. The goal is to achieve transparent flight operations in the NAS.
>
> *Establish the precedent.* Although focused on domestic use, any regulations enacted will likely lead, or certainly have to conform to, similar regulations governing UAS flight in International Civil Aviation Organization ("ICAO") and foreign domestic (specific countries') airspace.[80]

Following these precepts, military interests envision a separate and distinctive category of UAV regulations for air operations, operator certification, and right-of-way rules, but are cautious to adapt existing regulations to UAV activities.[81]

The DoD also has self-identified reliability, regulation, and sense-and-avoid as prerequisites to a "file and fly" regime. That is, to attain the goal of integrating UAVs into the national airspace, along with oceanic and domestic airspace, the DoD recognizes that it should:

1. Foster an airspace regulatory environment that encourages the safe use of UASs in non-segregated airspace,
2. Improve the flight reliability of UASs to equal or better that of their manned counterparts,
3. Secure the control and sensor/relay communications sent to and from UASs,[82]
4. Implement [a] two-track strategy to gain increased access to the [national airspace] for all UASs under the current COA process and attain a level of access of UAS . . . equivalent to that of manned aircraft,[83] and
5. Work with the FAA to define appropriate conditions and requirements under which a single pilot would be allowed to control multiple airborne UASs simultaneously.[84]

80. *See id.* at 103.

81. *See id.* at 111. The FAA currently regulates broad categories of aircraft, including airplane, rotorcraft, glider, and light-than-air, which themselves may be categorized as transport, normal, utility, acrobatic, limited, restricted, and provisional. *See* 14 C.F.R. § 1.1 (2009).

82. While advances in computer and communications technologies have enabled the development of autonomous unmanned systems, the risk of "lost link" whereby a UAV loses guidance signaling is real. DOD, UNMANNED SYSTEMS ROADMAP, *supra* note 78, at 116. In that event, UAVs can be programmed to climb to a predefined altitude to attempt to reestablish contact. *Id.*; *see also* 14 C.F.R. § 91.185 (establishing "NORDO" or no radio requirements).

83. This specific proposal is the product of a Tri-Service UAS Airspace Integration Joint Integrated Product Team—so-called JIPT—which was formed among the Air Force, Army, and Navy UAS program managers to coordinate related UAV technology and standards development. DOD, UNMANNED SYSTEMS ROADMAP, *supra* note 78, at 118.

84. *Id*. at 123-24.

If this "roadmap" is successfully followed over the next decade, military operations will offer important and useful precedent for civil and commercial UAV operators to access the national—and perhaps international—airspace more regularly than is allowed by the necessarily cumbersome COA and airworthiness review processes.[85]

D. AN INTERNATIONAL PERSPECTIVE

While the domestic airspace above the United States is unique, with respect to UAV integration, the emerging UAV laws in Australia, Japan, the United Kingdom, and the European Union community offer different approaches that might be incorporated and adopted into current and developing UAV policy in the United States. Australia's Civil Aviation Safety Authority (CASA), for example, has developed guidance to UAV controllers and manufacturers as to the construction, operation, and means by which UAV systems may safely and legally operate.[86] Akin to the FAA's COA process, CASA's UAV operator certification process permits the commercial operation of UAVs upon a satisfactory showing that such operations can occur safely based on the type and location of the mission.[87] Additionally, an Australian aerospace firm commissioned the "Unmanned Aircraft Technology Applications Research" program to address UAV issues and to form an Australian-New Zealand working group of operators, researchers, military aviators, and insurance underwriters focused on resolving inhibitors to UAV airspace integration.[88]

In Japan, UAVs have proved especially successful in the area of agriculture.[89] Driven by a declining and aging labor force, the Japanese Ministry of Agriculture, Forest, and Fisheries, together with its affiliate, the

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85. *See* FED. AVIATION ADMIN., Order 1110.150, SMALL UNMANNED AIRCRAFT SYSTEM AVIATION RULEMAKING COMMITTEE 1 (2008). "Based on the relatively low cost of small [UAVs, together] with their low operating expense, versatility for aerial photography, and other sensing applications," the FAA believes that "small [UAVs] will experience the largest near-term growth in civil/commercial [UAVs]." *Id.* The FAA has chartered an Aviation Rulemaking Committee (ARC) to propose final regulations governing small UAVs in early 2012. *See id.* at 2 (discussing the rules of the ARC).

86. Civil Aviation Safety Authority (Australia), CASR Part 101, *available at* http://www.casa.gov.au/scripts/nc.dll?WCMS:STANDARD::pc=PC_91039 (last visited Feb. 2, 2010).

87. *See* CIV. AVIATION SAFETY AUTH., ADVISORY CIRCULAR AC-101(0), UNMANNED AIRCRAFT AND ROCKETS, UNMANNED AERIAL VEHICLE (UAV) OPERATIONS, DESIGN SPECIFICATION, MAINTENANCE, AND TRAINING OF HUMAN RESOURCES Appendix 3 (2002) (explaining the requirements for operator certification).

88. *See* GOV'T ACCOUNTABILITY OFFICE, GAO NO. 08-511, UNMANNED AIRCRAFT SYSTEMS: FEDERAL ACTIONS NEEDED TO ENSURE SAFETY AND EXPAND THEIR POTENTIAL USES WITHIN THE NATIONAL AIRSPACE SYSTEM 26 (2008) [hereinafter GAO FEDERAL ACTIONS NEEDED].

89. DEP'T OF DEFENSE, AIRSPACE INTEGRATION PLAN FOR UNMANNED AVIATION, 40-41 (2004).

Japanese Agriculture Aviation Association (JAAA), promote the licensing of over 1500 unmanned helicopters for use in spraying and plowing rice fields.[90] The JAAA has established a registration system for all unmanned helicopters, developed safety standards in the areas of flight performance, airframes, and inspection and maintenance, and now requires all UAV users and operators to receive training and certification.[91] While illustrative of operations at least in uncontrolled and discrete airspaces—namely over fields—UAV operations in Japan nevertheless may offer some guidance for seamless integration of UAVs in broader categories of air space.[92]

The United Kingdom, meanwhile, through the Directorate of Airspace Policy of the UK Civil Airspace Authority (CAA), had developed with respect to UAV operation a regulatory framework in the form of a document entitled "Unmanned Air Vehicle Operations in UK Airspace—Guidance" that provides:

> [i]t is CAA policy that [UAVs] operating in the UK must meet at least the same safety and operational standards as manned aircraft. Thus [UAV] 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, whilst in the air or on the ground than that attributable to the operations of manned aircraft of equivalent class or category.[93]

While this regulatory guidance no longer applies in the UK because the European Union's Aviation Safety Agency now has jurisdiction over UAV regulatory matters, the UK's legal framework is instructive. It categorizes UAVs into five segments based upon the particular class of airspace in which each UAV would operate.[94] Categorizing UAVs for purposes of national airspace integration may well be helpful in encouraging uniformity as the United States creates its own regulations permitting full UAV access to the national airspace. For now, at this early but active stage in UAV development, the FAA is working with international bodies, including the European Organization for Civil Aviation Equipment (EUROCAE), the European Organization for the Safety of Air Navigation (EUROCONTROL), and the International Civil Aviation Organization (ICAO) to

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90. *Id.*

91. *Id.* at 41.

92. Peterson, *supra* note 14, at 587-88. *See generally* Tim Mahon, *Fit to Fly in Civil Airspace,* in 2003 YEARBOOK 162-168, at 166 (UVS Intl, Blyenburgh & Co. 2003).

93. CIVIL AVIATION AUTH. (U.K.), CAP 722, UNMANNED AERIAL VEHICLES IN CIVIL AIR SPACE-GUIDANCE, Ch. 1. § 1.1 (2002).

94. Peterson, *supra* note 14, at 590-91; *see also* FED. AVIATION ADMIN., UAS OPERATIONS, *supra* note 41, at 13, § 8.2.14.

leverage mutual expertise and resources with respect to global standards and practices for UAV operation.[95] Harmonizing UAV standards and procedures globally presents an enduring challenge.

IV. CONCLUSION

UAVs are transformational technologies.[96] Their application in the military and civil arenas, in both domestic and international forums, is robust and evolving relentlessly. For example, the Israel Space Agency has commented that the numbers of unmanned aircraft in the Israel Air Force will outnumber manned aircraft in 20 years.[97] But American lawmakers and the general population alike are understandably cautious, if not apprehensive, about integrating UAV operations into the already busy airways amid post-September 11, 2001, national security concerns. As a practical matter, as valuable as automation is in today's global marketplace, the notion of airplanes without pilots is uncomfortable for many people at a deep level, as the human element remains critical in aviation—a fact reinforced in January 2009 when Captain Chesley "Sully" Sullenberger successfully and remarkably ditched a commercial airplane into the Hudson River in New York after a bird strike disabled the entire power-plant of a jetliner.

Against this backdrop, the United States Government Accountability Office has synthesized the challenge of UAV operations:

> Routine UAS access to the national airspace system poses a variety of technological, regulatory, workload, and coordination challenges. Technological challenges include developing a capability for UASs to detect, sense, and avoid other aircraft; addressing communications and physical security vulnerabilities; improving UAS reliability; and improving human factors considerations in UAS design. A lack of regulations for UASs limits their operations and leads to a lack of airspace for UAS testing and evaluation and a lack of data that would aid in setting standards. Increased workload would stem from FAA's expectation of increased demand for UAS operations in the national airspace system without a regulatory framework in place. In addition, coordination of efforts

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95. Convention on International Civil Aviation, Dec. 7, 1944, 61 Stat. 1180, 15 U.N.T.S. 295 (governing global civil aviation standards). This treaty is more commonly known as the 1944 Chicago Convention.

96. ELIZABETH BONE & CHRISTOPHER BOLKCOM, UNMANNED AERIAL VEHICLES: BACKGROUND AND ISSUES FOR CONGRESS, CRS-3 (2003), *available at* http://www fas.org/ irp/crs/RL31872.pdf (last visited Mar. 8, 2010).

97. GAO FEDERAL ACTIONS NEEDED, *supra* note 88, at 38.

> is lacking among diverse federal agencies as well as academia and the private sector in moving UASs toward meeting the safety requirements of the national airspace system.[98]

From a legal and enforcement perspective as well, two important questions remain. First, do the interim guidelines established by the FAA carry the force and consequences of law? And second, is it the role of a judge to decide if those guidelines are regulatory in nature as opposed to a violation of a FAR?[99]

While UAV operational vulnerabilities and open-ended legal and practical questions remain, the national airspace can and should accommodate UAVs in the near future in a manner that caters to safety and national security. One study recommends ten actions for integrating UAVs over the next several years:

> (1) [agreeing] upon a concept of operations for UAV flight in civil airspace; (2) [developing] a classification scheme and definitions for UAVs as they relate to operations in civil airspace; (3) [establishing] regulations for UAV system certification, flight operations, and ground controller qualifications; (4) [developing] effective technologies and procedures to prevent collisions of UAVs with other aircraft, the ground, or other obstacles; (5) [instituting] security controls and approvals for UAV operations; (6) [developing and implementing] communications solutions for UAV systems; (7) [developing] an aeronautical data exchange, processing, and synchronization network that accounts for unique UAV requirements; (8) [harmonizing] UAV regulations, certification standards, and operational procedures; (9) [ensuring] interoperability with the air traffic system and assessing potential

98. *Id*. at 16. Consolidating the vast number of viewpoints on the issue of UAV integration may be a necessary first step to crafting a streamlined and uniform policy respecting UAV operations in the domestic and international airspace. The long list of government and industry initiatives and organizations concerning UAV airspace operations alone is illustrative of the fact that solutions to the technological, regulatory, workload, and coordination challenges for UAVs are only in an initial phase of development. Among the voices in the UAV policy dialogue are Technical Analysis and Application Center (TAAC), Joint Planning and Development Office (JPDO), UAV National Task Force (UNTF), UAV National Industry Team (UNITE), Access 5, Joint Aviation Authority-Eurocontrol UAV Task Force, UAV Thematic Network (UAVNET), Civil UAV Applications and Economic effectiveness of potential CONfiguration solutions (CAPECON), UAV Safety Issues for Civil Operation (USICO), UAV's Concerted Actions for Regulations (UCARE), and Euro UAV Industry Consultative Body (ICB), Association for Unmanned Vehicle Systems International (AUVSI), American Society for Testing and Materials (ASTM), Unmanned Vehicle Systems International, Unmanned Aerial Vehicle Systems Association, American Institute of Aeronautics, and Astronautics Unmanned Systems Program.

99. Interview with S.V. (Steve) Dedmon, Assistant Professor, Embry-Riddle Aeronautical Univ., in Daytona Beach, Fla. (Dec. 3. 2009).

> impacts on the air traffic system and its regulatory and operational environment; [and] (10) [gaining] public acceptance and actively communicating with all potential affected parties.[100]

Until a single policy is adopted, the emergence of UAVs presents nearly a clean slate for lawmakers to craft a regulatory environment that enhances the interrelated objectives of commerce, safety, and national security. For the UAV industry to thrive, insurers, engineers, manufacturers, operators, military tacticians, and other stakeholders must have a firm and predictable set of laws that establish rights and liabilities emanating from UAV operations. This is not to say that lawmakers should throw caution to the wind by enacting an overly progressive set of rules that stimulates UAV development at the expense of other valid legal and practical concerns. Lawmakers should not wait passively for the UAV industry to offer absolute assurances relative to UAV functionality, either. Rather, UAV-related law and policy should stimulate industry advances and progress hand-in-hand, while ensuring the legislative and judicial function of promoting contract, tort, property, and regulatory rights that promote the public welfare.

To that end, recent (albeit stalled) efforts by the United States Congress to develop and fund a plan for the safe integration of commercial unmanned aircraft systems into the national airspace as soon as possible, and perhaps by 2012, should be applauded.[101] Moreover, the fact that United States Senators Byron Dorgan and Kent Conrad and Congressman Earl Pomeroy recently obtained final approval of Section 935 of the National Defense Authorization Act for 2010 to establish North Dakota as a veritable test-bed for UAV development and integration into the national airspace bodes well for the future of regular, safe, and lawful UAV activity.[102] Ultimately, the current standing of UAV law is unmistakable: all stakeholders are at the

100. MATTHEW T. DEGARMO, ISSUES CONCERNING INTEGRATION OF UNMANNED AERIAL VEHICLES IN CIVIL AIRSPACE viii (2004), *available at* http://www mitre.org/work/tech_papers/tech_papers_04/04_1232/04_1232.pdf (last visited Mar. 8, 2010). The study provides an estimated timeframe for each action. *Id.* at 3-1-3-4. "The overarching goal of the UAV community is clear: Achieve routine and safe integration of UAVs into the civil airspace." *Id.* at 3-1.

101. H.R. 2881, 110th Cong., §§ 321-24 (2007). The FAA Reauthorization Act of 2007, which passed a vote of the House of Representatives but did not reach the Senate, would have required the FAA Secretary to determine (i) the types of unmanned aircraft systems, if any, as a "result of their size, weight, speed, operational capability, proximity to airports and population areas, and operation within visual line-of-sight that do not create a hazard to users of the national air system or the public," and (ii) whether a certificate of authorization or airworthiness certification under existing law would be required for the operation of unmanned aircraft systems. *Id.* § 322.

102. Press Release, Byron Dorgan, U.S. Senator, Delegation Says Congress-Approved Bill Will Help North Dakota Become Hub of UAV Research Training (Oct. 23, 2009), *available at* http://dorgan.senate.gov/newsroom/record.cfm?id=319286.

proverbial starting line, and to realize the full benefits of unmanned aviation activity, further significant manual work remains undone.