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Lost in Debate: The Safety of Domestic Unmanned Aircraft Systems

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Lost in Debate: The Safety of Domestic Unmanned Aircraft Systems

Abstract

The United States is poised to integrate commercial unmanned aircraft systems (UAS) into the national airspace and enable government entities to use UAS in a more expedient manner. This policy change, mandated by the Federal Aviation Administration (FAA) Modernization and Reform Act of 2012, offers new economic, social and scientific opportunities as well as enhanced law enforcement capacity. However, such benefits will be accompanied by concerns over misuse and abuse of the new technologies by criminals and terrorists. Privacy has been the focus of public debate over the more widespread use of UAS. This paper examines a variety of issues related to allowing broad UAS operations in domestic airspace, and puts forth that safety should be the top priority of policy makers in their effort to integrate UAS into the national airspace system.

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Introduction

The use of unmanned aircraft systems (UAS) has generated considerable attention and controversy over its legal, moral, and strategic implications. The most prominent issue comes from the Obama administration's decision to exponentially increase the use of UAS or drones in counterterrorism operations around Pakistan and Yemen. The extensive deployment of armed drones overseas has spurred a great deal of debate, often criticism, over the legality of targeted killings and military strikes conducted in sovereign states without a formal declaration of war. Nonetheless, the rapid expansion of the drone industry and technological innovations resulting from the intensifying use of UAS in the past several years have inspired both the U.S. government and private entities to seek domestic applications for unmanned aircraft and their supporting networks.

The passage of the FAA Modernization and Reform Act (FMRA) signed by President Obama on February 14, 2012 opened the door for the commercial use of drones that was previously prohibited. Government operators of UAS are hoping the 2012 legislation will expedite the currently long and cumbersome approval process. This new prospect has set off both excitement and alarm. The UAS market is expected to bring new economic benefits, contribute to scientific development, and potentially provide consumers with enhanced convenience. The growing use of UAS, however, also has brought much consternation over the privacy issue and for valid reasons. The modern day UAS is distinguished from earlier models not only in the aircraft's ability to fly higher and longer but also by the data-linked network of aircraft and command and control stations. Such features allow considerably improved surveillance capability that many fear will be abused by both the government and private citizens.[1] Also, related to lexicon, it should be noted that the terms, unmanned aerial vehicle (UAV), unmanned aircraft systems (UAS), and drones are used interchangeably by the media and policy makers as well as the general public.[2] Nonetheless, UAS is the official term employed by the Federal Aviation Administration (FAA) and the FAA Modernization and Reform Act.

This article first provides a brief history of the development of UAS and the existing policy regulating its use. Such background information is followed by discussions on the risks and opportunities that the integration of UAS into

[1] U.S. Department of Transportation, "Integration of Civil Unmanned Systems (UAS) in the National Airspace System (NAS) Roadmap," *Federal Aviation Administration*, November 2013, 8, available at: *http://www.faa.gov/uas/media/uas_roadmap_2013.pdf*.
[2] Elias, Brat, *Pilotless Drones: Background and Considerations for Congress Regarding Unmanned Aircraft Operations in the National Airspace System*, CRS Report R42718 (Washington, D.C.: Library of Congress, Congressional Research Service, September 10, 2012): 1, available at: *http://fas.org/sgp/crs/natsec/R42718.pdf*.

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domestic airspace can bring. While examining the benefits and costs of increased UAS operations, this article focuses on the issue of safety, as it has not generated the level of attention it deserves in the public debate. Based on the analysis, this article puts forth that the safety of UAS operations in domestic airspace should be the top priority for policy makers and rule making bodies in developing and implementing new policies under the direction laid out by the 2012 legislation.

Unmanned Aircraft Systems: Origins and Present Use

Akin to many other technological innovations, the origin of UAS is traced back to military applications. Originally, balloons were thought of as a primitive way to fly an object without human control onboard. Austrians are believed to be the first to use some 200 balloons to drop bombs in Venice during fighting with Italy in 1849. The United States also employed balloons for military purposes during the Civil War. Both Union and Confederate soldiers launched balloons laden with explosives, but their attempts were deemed to be ineffective.[3] The development of the Kettering Aerial Torpedo during World War I is considered the technological genesis of the modern day attack drones.[4] Also known as the "Bug," the model was designed to release its wings to crash into the target, detonating 180 pounds of explosive when its engine was switched off.[5] However, the prototype was not deployed and with the end of WWI, the importance of further development waned as well.[6]

Interest revived with the beginning of WWII, and a number of attempts were made to improve the ability of remote control devices, though the funding and priority for such development were not consistent. A technological breakthrough was achieved by Abraham Karem, an emigrant engineer from Israel, who in 1981 demonstrated an aircraft named the "Albatross," that was able to stay in the air for fifty-six hours. An updated version of the Albatross, the GNAT-750 by General Atomics Aeronautical Systems demonstrated its intelligence and surveillance value to the U.S. military during the Bosnian war in 1994 when it delivered images of Serbian artillery.[7]

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[3] Ian G.R. Shaw, "The Rise of the Predator Empire: Tracing the History of U.S. Drones," *Understanding Empire,* 2013, available at: *http://understandingempire.wordpress.com/2-0-a-brief-history-of-u-s-drones/*; Jim Garamone, "From U.S. Civil War to Afghanistan: A Short History of UAVs," *DOD News,* April 16, 2002, available at: *http://www.defense.gov/news/newsarticle.aspx?id=44164.*
[4] Shaw, "The Rise of the Predator Empire"; "Kettering Aerial Torpedo 'Bug'," *National Museum of the US Air Force*, March 25, 2014, available at: *http://www.nationalmuseum.af.mil/factsheets/factsheet.asp?id=320.*
[5] "Kettering Aerial Torpedo 'Bug'."
[6] Shaw, "The Rise of the Predator Empire."
[7] Ibid.

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The post September 11th agenda of the United States provided critical momentum for the use of UAV or UAS in fighting terrorists, especially under the Obama administration. While attack drones such as Predators and Reapers are most widely known as a result of their use in counterterror operations, the U.S. military procured and currently possesses over a dozen different types of UAS greatly varying in size and purpose.[8]

The extensive use of military UAS overseas has put a spotlight on the growing interest in unmanned aircraft for domestic civilian applications. The use of UAS in U.S. airspace is largely categorized by three types; recreational, public use, and commercial purposes. The technological spillover of earlier military drones was first and mostly enjoyed by hobbyists who were flying radio-controlled model aircraft. The Academy of Model Aeronautics was created in 1936, and the organization currently boasts 170,000 members.[9] The Drone User Group Network founded in 2012 has over 5,000 members outside the military.[10] In addition to hobbyists, public entities such as federal agencies, state and local governments, and universities have been using UAS with appropriate permits for the purposes of law enforcement, disaster relief, scientific research, and border patrol.

Among federal entities, the Department of Defense, the National Aeronautics and Space Administration (NASA), Department of Interior, Department of State, and Department of Energy have flown UAS. While no details are disclosed, the Federal Bureau of Investigation (FBI) revealed that the FAA granted the bureau permission to use drones four times in 2010, 2011, and 2013. Besides the FBI, the Drug Enforcement Administration (DEA) and the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) are known to have fleets of UAS.[11] Customs and Border Protection (CBP), under the Department of Homeland Security, utilizes UAS extensively and has collaborated with a number of state and local law enforcement agencies. CBP has also provided support to the U.S. Coast Guard, Immigration and Customs Enforcement (ICE), FAA, FBI, Federal Emergency Management Agency (FEMA), DEA, and U.S. Marshals, among others.[12] Civil

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[8] U.S. Department of Defense, *Unmanned Systems Integrated Roadmap: FY 2013-2038* (Washington, D.C.: OSD, 2013): 5-6, available at: *http://www.defense.gov/pubs/DOD-USRM-2013.pdf*.
[9] Elias, "Pilotless Drones," 2; "What is AMA?" *Academy of Model Aeronautics*, available at: *http://www.modelaircraft.org/aboutama/whatisama.aspx*.
[10] Michael S. Rosenwald, "A Drone of Your Very Own," *Washington Post,* August 18, 2013, A7; "About the Drone User Group Network," *Drone User Group Network*, 2014, available at: *http://www.dugn.org/about.html*.
[11] Craig Whitlock, "FAA says it authorized 4 FBI drone missions," *Washington Post,* June 21, 2013, A7.
[12] Jennifer Lynch, " Customs & Border Protection Loaned Predator Drones to Other Agencies 700 Times in Three Years According to 'Newly Discovered' Records," *Electronic Frontier Foundation*, January 14, 2014, available at:

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operations are severely limited since commercial use of UAS is prohibited under existing regulations. Consequently, civil operations of UAS have been largely conducted by the manufacturers, most notably General Atomics Aero System and Raytheon, for development and testing of prototypes.[13]

Rules and Regulations

The regulatory framework managing UAS operations has developed only recently and slowly. The existing protocols for UAS operations in national airspace were deemed increasingly inadequate to manage the growing demand of UAS use. This section analyzes the evolution of rules and regulations regarding the use of UAS in domestic airspace. The discussion on the 2012 FMRA also includes the progress the FAA has made in accordance with the law.

Ad hoc Regulations

The main concern behind the FAA's initial rule was the safe operation of model aircraft. The FAA published operating standards for model aircraft in 1981. This one page circular was cited as the basic rules on flying model aircraft for recreational purposes. The operating standards required hobbyists to fly their model aircraft in a location distant from crowded areas and not to fly them "higher than 400 feet above the surface." The operator of the model aircraft was also advised to notify the airport operator or control tower "when flying aircraft within 3 miles of an airport."[14] However, the circular was merely advisory with no enforceable authority. The advisory also pertained only to using model aircraft for recreational purposes, since no other utility such as for law enforcement or for-profit purposes had yet materialized.

In order to cope with the rapid growth in the number and technological sophistication of UAS through the 1990s and 2000s, the FAA set out a policy guideline in the 2007 Federal Register notice.[15] In essence, the notice

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https://www.eff.org/deeplinks/2014/01/newly-discovered-drone-records-show-customs-border-protection-flew-its-predator; "Drone Flights in the U.S.: Customs & Border Protection Drone Flight List," *Electronic Frontier Foundation*, available at: *https://www.eff.org/document/customs-border-protection-drone-flight-list*, "Drone Flights in the U.S.: Customs & Border Protection Drone Flight List—supplemental," *Electronic Frontier Foundation*, available at: *https://www.eff.org/document/eff-v-dhs-cbp-supplemental-agency-list*.

[13] "A List of Special Airworthiness Certificates—Experimental Category (SACs)," *Electronic Frontier Foundation*, available at: *https://www.eff.org/document/faa-list-special-airworthiness-certificates-experimental-categorysacs*.

[14] U.S. Department of Transportation, "Advisory Circular," *Federal Aviation Administration*, June 9, 1981, available at: *http://www.faa.gov/documentlibrary/media/advisory_circular/91-57.pdf*.

[15] U.S. Department of Transportation, "Unmanned Aircraft Operations in the National Airspace System," *Federal Register* 72:29 (February 13, 2007), available at: *http://www.gpo.gov/fdsys/pkg/FR-2007-02-13/pdf/E7-2402.pdf*.

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promulgated that anyone who wishes to operate UAS for non-recreational purposes should seek and obtain a permit. More specifically, of the three categories discussed earlier, recreational users are not required to obtain permits to operate their UAS, and public entities such as government agencies and universities can apply for the Certificate of Waiver or Authorization (COA) from the FAA.[16] According to a Government Accountability Office (GAO) analysis, there were 391 licenses issued in 2012, 52 percent of which accounted for certificates issued to the Department of Defense (DOD) for "training and operational missions." Academic institutions obtained ninety-one certificates followed by NASA at thirty-five.[17]

Civil operations, on the other hand, require Special Airworthiness Certificates in the experimental category.[18] Other than industry manufacturers, no profit-centered, private parties were granted with permission to operate UAS under the regulatory regime preceding the 2012 legislation. Such a regulatory framework was deemed inadequate to manage the fast rising number of UAS users and technological advancements in the UAS field. There was a prevailing view that operating aircraft below 400 feet over private property was not subject to FAA regulation, whether such operation was for recreation or for profit, despite the 2007 Federal Register notice barring commercial operation of UAS.[19] The confusion was particularly prevalent among farmers since they tend to fly small UAS on large farmland remote from densely populated areas much like hobbyists. However, farmers use UAS to survey topography, identify insect or weed infestations, and help determine what crops to plant and when to sell them. Use of UAS has also enabled farmers to apply fertilizer or pesticides to precise and specific areas, achieving cost savings.[20] Therefore, these UAS operations are considered to be for commercial purposes and have been proscribed per the 2007 Federal Registrar notice. Nonetheless, there was no enforcement against agricultural UAS under the 2007 notice, which contributed to many farmers

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[16] "Unmanned Aerial Systems: Public Operations (Governmental)," *Federal Aviation Administration*, August 8, 2014, available at: *https://www.faa.gov/uas/public_operations/*.
[17] Gerald L. Dillingham, "Unmanned Aircraft Systems: Continued Coordination, Operational Data, and Performances Standards Needed to Guide Research and Development," Testimony before the Subcommittee on Oversight, Committee on Science, Space, and Technology, *U.S. House of Representatives*, February 15, 2013, 4-5, available at: *http://www.gao.gov/assets/660/652223.pdf*.
[18] U.S. Department Transportation, "Unmanned Aerial Systems: Civil Operations (Non-Governmental)," *Federal Aviation Administration*, available at: *https://www.faa.gov/uas/civil_operations/*.
[19] U.S. Department of Transportation, "Busting Myths about the FAA and Unmanned Aircraft," *Federal Aviation Administration*, March 7, 2014, available at: *http://www.faa.gov/news/updates/?newsId=76240*.
[20] Christopher Doering, "Growing use of drones poised to transform agriculture," *USA Today,* March 23, 2014.

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operating UAS under the assumption that their activities were categorized as a hobby.

Post the 2012 FAA Modernization and Reform Act

Ironically, with the enactment of the 2012 bill, the essence of which was to facilitate commercial use of UAS, the FAA began to tighten enforcement of the ban on UAS operations for business purposes. This effort was an attempt to clarify the existing policy before taking up the formulation of a new one. In 2012, Raphael Pirker was fined $10,000 for operating a UAS for commercial purposes without license, and "in a careless and reckless manner so as to endanger the life or property of another." Pirker flew a remotely controlled glider to record an aerial view of the University of Virginia Medical Center for a promotional video in 2011.[21] The case had a chilling effect on UAS users and was seen as a roadblock to agricultural UAS, which is expected to be the largest sector for commercial use when its use is allowed. However, Patrick Geraghty, a National Transportation Safety Board administrative judge, dismissed the penalty citing that "there was no enforceable FAA rule…applicable to model aircraft or for classifying model aircraft as an UAS."[22] The decision, which the FAA appealed, further illustrated the confusion over and inadequacy of existing regulations.

On the whole, supporters of UAS perceive the FMRA as an impetus to the integration of UAS into U.S. airspace. The legislation required the administration to create a comprehensive blueprint for allowing the commercial use of UAS that had been banned previously. Also mandated were setting standards for the Certificate of Authorization rather than on a case-by-case basis so that government agencies can obtain certificates in an efficient manner. The 2012 Act requires the Administration to integrate "civil UAS into the national airspace system by September 30, 2015." For this eventual goal, the law mandated a number of important benchmarks including developing "a comprehensive plan to safely accelerate the integration of civil unmanned aircraft systems into the national airspace system" and providing "a 5-year roadmap for the introduction of civil UAS into the national airspace system" within a year of passage of the law.[23] Both of these requirements missed their deadlines, raising questions on whether the FAA would be able to develop and implement a plan for the integration of UAS into domestic airspace by 2015. The delay was due partly to the ambitious timeline proposed by the legislation, and partly because it aroused

[21] Mike M. Ahlers, "Pilot wins case against FAA over commercial drone flight," *CNN,* March 6, 2014, available at: *http://www.cnn.com/2014/03/06/us/drone-pilot-case-faa/*.
[22] Ibid.
[23] FAA Modernization and Reform Act of 2012, Public Law Number 112-95, 126 Stat.11 (February 14, 2012).

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concern over privacy issues. The comprehensive plan was released in September 2013, followed by the roadmap, issued in November 2013.[24]

One of the FMRA provisions that attracted significant attention is the pilot program to establish six test sites. The FAA issued a request for proposals from public entities that wished to be designated as one of the six test ranges in February 2013. The selection of the test sites was based on technical criteria including "geographic diversity, climatic diversity, location of ground infrastructure and research needs, population density and air traffic density, as well as specific goals and objectives to be accomplished."[25] In December 2013, the FAA announced the six sites. They were the University of Alaska, State of Nevada, New York's Griffiss International Airport, North Dakota Department of Commerce, Texas A&M University at Corpus Christi, and Virginia Polytechnic Institute and State University (Virginia Tech). Some of these states planned joint cooperation with other states.[26] Another pilot project involved the use of UAS in the Arctic.

Prior to the enactment of the FMRA, UAS was used by researchers and public entities in Alaska—whose mission included studying climate change— for counting wildlife animal populations, and for monitoring forest fires. Alaska's vast landmass and severe climate commanded special needs for UAS, and their users had hoped for a more efficient permit process. Alaska Senator Mark Begich successfully incorporated an amendment that would allow permanent use of UAV in designated areas in the Arctic.[27] There have been two UAS operations authorized in the Arctic. The FAA approved ConocoPhillips to operate the small ScanEagle UAS to survey ice floes and whales in order to alleviate environmental risks.[28] The second approval was granted to BP, another oil giant, in June 2014. BP flew a Puma AE manufactured by AeroVironment to inspect oil fields in

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[24] Department of Transportation, "Unmanned Aircraft Systems (UAS) Comprehensive Plan: A Report on the Nation's UAS Path Forward," *Joint Planning and Development Office*, November 6, 2013, available at: *http://www.faa.gov/about/office_org/headquarters_offices/agi/reports/media/UAS_Comprehensive_Plan.pdf* .

[25] Department of Transportation, "FAA Announces Request for Proposals for Unmanned Aircraft Systems Research and Test Sites," *Federal Aviation Administration,* February 14, 2013.

[26] Department of Transportation, "FAA Selects Six Sites for Unmanned Aircraft Research," *Federal Aviation Administration*, December 30, 2013, available at: *http://www.faa.gov/news/updates/?newsId=75399*; Graham Warwick, "Who Pays, Wins; With economic boom potential, FAA's chosen UAS test sites must first find funds to begin operations," *Aviation Week and Space Technology,* 176:1 (January 13, 2014).

[27] Ben Anderson, "Unmanned Aerial Drones the Future of Arctic Reconnaissance?" *Alaska Dispatch News,* February 13, 2012, available at: *http://www.adn.com/article/unmanned-aerial-drones-future-arctic-reconnaissance.*

[28] Ed Crooks, "Conoco in Landmark Alaska drone flight," *Financial Times,* September 25, 2013, available at: *http://www.ft.com/cms/s/0/3c43d580-2575-11e3-9b22-00144feab7de.html#axzz3C2adPmYC.*

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Prudhoe Bay, Alaska.[29] They marked the two first Certificates of Authorization approved for commercial UAS operations.

In another step toward fulfilling the FMRA, the FAA issued a guideline for model aircraft operators in June 2014. The guideline encourages the operators to "contact the airport or control tower when flying within 5 miles of airport," and not to "fly near manned aircraft," and "beyond line of sight of the operator" for safety. The FAA also considers the weight of an aircraft used for recreational purposes to be less than 55 lbs. unless "it's certified by an aeromodeling community-based organization."[30]

Economic Opportunities and Strategic Considerations

The advancement of UAS technology has stirred an important public debate over the prospective benefits and risks of UAS use. Supporters of flying UAS in domestic airspace believe that the potential application of UAS is limited only by imagination. The benefits of UAS operations can be reaped by both public and private entities.

Public Safety

From the law enforcement perspective, UAS enables more effective border control and improved public safety. Already, law enforcement agencies use the burgeoning technology for monitoring and assisting with the arrest of criminals. Wildfires could be better observed, and storms and hurricanes can be better surveyed and studied without risking human lives. The UAS advocates argue that such possibilities should not be hindered by inadequate government regulations. Many entrepreneurs see a business potential. Both small businesses and large corporations such as Amazon are keenly interested in creating a new market.[31]

Economic Potential

The biggest attraction for commercial UAS is economic. According to the Association for Unmanned Vehicle Systems International's (AUVSI) estimates, the industry could create 70,000 new jobs and a $14 billion market in the first three years after UAS is incorporated into the national airspace.[32] Expectations

[29] Bart Jansen, "FAA approves first commercial drone over land," *USA Today,* June 10, 2014, available at: *http://www.usatoday.com/story/money/business/2014/06/10/faa-drones-bp-oil-pipeline-aerovironment-north-shore/10264197/*.
[30] Department of Transportation, "What Can I Do With My Model Aircraft" Hobby/Recreational Flying," *Federal Aviation Administration*, August 12, 2014, available at: *http://www.faa.gov/uas/publications/model_aircraft_operators/*.
[31] Jen DiMascio, "On Deck: Industry Cautious about Growth for Civilian UAVs in U.S. Market," *Aviation week & Space Technology,* 174:5 (February 6, 2012).
[32] Rosenwald, "A Drone of Your Very Own."

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over such tangible benefits were a large force behind the enactment of the FMRA. Although the 2012 legislation did not authorize funds for the testing sites, the lack of funding did not dampen anticipation for the greater economic benefits that UAS might afford over the long term. Twenty-four states competed to be selected as one of the six testing sites, and many U.S. senators, representatives, and local leaders promoted their states and cities.[33] According to the Teal Group, an industry market research firm, civil operation is forecasted to make up 11 percent of the drone market valued at $6.4 billion worldwide in 2014, growing to 14 percent in 2024. The UAS market is projected to reach $11.5 billion by then. The United States is expected to account for 65 percent of the world's research, development, testing and evaluation, and 41 percent of the world's procurement over the next ten years owing to its large military UAS programs.[34]

Global Competitiveness

Proponents of UAS and its industry raise international competition and the U.S. position in the growing world market for UAS. Japan has been widely using UAS for agricultural applications since the 1990s to overcome the problem of an aging farming population, and regulatory issues have been addressed already.[35] The 2014 estimated share of U.S. procurement in the world market at 41 percent would be a significant drop from 55 percent in the 2013 forecast.[36] The winding down of two wars in the Middle East (though unfolding international developments in the region could increase demand for UAS), coupled with an austere budget environment, could strain the U.S. drone industry. Global competition is already underway, with at least a dozen other countries manufacturing indigenous UAS.[37] This raises the question of how the United States can maintain its edge in the UAS industry while rapidly demobilizing its existing fleet in a way that would not cause a superfluous inventory of unmanned aircraft. Invigorating the drone industry for commercial purposes will help keep the production line hot for industry and maintain the U.S. competitiveness on the global market.

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[33] Warwick, "Who Pays, Wins; with economic boom potential."
[34] "Teal Group Predicts Worldwide UAV Market Will Total $91 Billion in Its 2014 UAV Market Profile and Forecast," *Teal Group Corporation*, July 17, 2014, available at: *http://www.tealgroup.com/index.php/about-teal-group-corporation/press-releases/118-2014-uav-press-release*.
[35] Harrison, Glennon J., *Unmanned Aircraft Systems (UAS): Manufacturing Trends*, CRS Report R42938 (Washington D.C.: Library of Congress, Congressional Research Service, January 30, 2013): 6, available at: *http://fas.org/sgp/crs/natsec/R42938.pdf;* Sara Sorcher, "What Drones Can Do for You," *National Journal,* April 11, 2013.
[36] Harrison, "Unmanned Aircraft Systems (UAS): Manufacturing Trends," 2.
[37] Kristin Roberts, "When the Whole World Has Drones," *National Journal Magazine,* March 21, 2013, available at: *http://www.nationaljournal.com/magazine/when-the-whole-world-has-drones-20130321; The Guardian,* "Drones by country: who has all the UAVs?," *Datablog ,* *http://www.theguardian.com/news/datablog/2012/aug/03/drone-stocks-by-country*.

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At issue is also the export policy regulating sales of military UAS in foreign markets. China and Israel are accelerating development and export of their UAS.[38] According to Frost & Sullivan, Israel became the leading exporter of UAS in sales of aircraft and its supporting systems such as payloads and operating systems worth approximately $4.6 billion between 2005 and 2012. This figure topped U.S. sales at $2 and $3 billion.[39] China has been stepping up production and sales of its UAS and is emerging as a strong competitor in the drone export market.[40] While the United States holds the edge in technology and production of military UAS, the United States is selective in selling its armed drones and sells them only to several close allies based on strategic concerns. In addition, as a signatory to the Missile Technology Control Regime (MTCR), the United States voluntarily restrains its export of UAS. MTCR provisions include limiting the proliferation of UAS "capable of carrying a 500 kilogram payload at least 300 kilometers, as well as systems intended for the delivery of weapons of mass destruction."[41] Industry representatives are hoping to see a change in export controls.

Managing Risks

Economic and other opportunities galvanized efforts to overhaul the inadequate rules and regulations governing UAS activity. The endeavor succeeded, and the FAA is developing a plan to integrate UAS into the national airspace system in accordance with the FMRA. However, many have also expressed unease over the potential for misuse. Moreover, the prospect of increased numbers of UAS presents critical questions of how to ensure airspace safety not only for the UAS flights themselves but also for other air traffic, and how to avoid the possible misuse of the latest technology.

Criminal and Security Risks

One concern is that criminals could use UAS technology for menacing purposes. Already, it has been reported that the Revolutionary Armed Forces of Colombia (FARC) and drug cartels in the region have sought to use remote-controlled submarines for cocaine smuggling. In Brazil and the United Kingdom, unmanned aircraft were flown to deliver cell phones and drugs to inmates in prions. Industrial espionage, voyeurism, and stalking are all unsavory aspects of drone

[38] Harrison, "Unmanned Aircraft Systems (UAS): Manufacturing Trends," 6.
[39] Tia Goldenberg, "Israel becomes world's largest exporter of drones," *Postmedia Breaking News,* June 5, 2013.
[40] Andrea Shalal, "U.S. firms urge new export policy for drones, change near," *Reuters,* July 18, 2014, available at: *http://www.reuters.com/article/2014/07/18/us-airshow-britain-usa-drones-idUSKBN0FN1Z320140718*.
[41] "Objectives of the MTCR," *Missile Technology Control Regimes*, available at: *http://www.mtcr.info/english/objectives.html*.

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activity.[42] On the security front, the scenario that terrorists might attempt to launch a UAS attack has turned out to be more than a theory. In November 2011, the FBI arrested a Massachusetts man charged with planning to fly a model aircraft filled with explosives to destroy the Pentagon and the Capitol although he was never close to executing the plan.[43]

Representative Michael T. McCaul, the chairman of the Subcommittee on Oversight, Investigations, and Management of the House Homeland Security Committee, held a hearing on the potential risks of expanded UAS operations, including possible technical problems such as spoofing or jamming of communications systems between the aircraft and ground control.[44] Criminals and terrorists could turn the government's increased use of UAS for law enforcement, surveillance and intelligence gathering to their advantage by exploiting these technical vulnerabilities to interfere with UAS operations or intercept information being transmitted from UAS to a ground control station. The hearing exposed that while DHS, particularly its Transportation Security Administration, seemed to be the reasonable entity to take a leadership role in preventing possible terror attacks by UAS; scant attention has been paid to this problem.[45] Nonetheless, many believe that banning the use of a promising technology for fear of abuse is a grossly misguided approach in dealing with terrorism since other modes of transportation can be used for terror attacks yet no one is proposing to outlaw cars, trucks and airplanes.[46]

Privacy and Civil Liberties Concerns

In public debate over UAS, privacy and civil liberties is the focus of scrutiny. Law often lags behind technology, and the government use of UAS is anticipated to generate questions regarding privacy, Fourth Amendment search and seizure, and due process. To some, drone strikes targeting terror suspects, especially American citizens, have made UAV or UAS into a symbol of government's ability to threaten civil liberties and deprive the due process guaranteed by the Fifth

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[42] Marc Goodman, "WAR & TERRORISM: Criminals and Terrorists Can Fly Drones Too," *Time*, January, 31, 2013, available at: *http://ideas.time.com/2013/01/31/criminals-and-terrorists-can-fly-drones-too/*.
[43] Peter Finn, "Mass. Man accused of plotting to hit Pentagon and Capitol with drone aircraft," *Washington Post,* September 28, 2011, available at: *http://www.washingtonpost.com/national/national-security/mass-man-accused-of-plotting-to-hit-pentagon-and-capitol-with-drone-aircraft/2011/09/28/gIQAWdpk5K_story.html.*
[44] "Using Unmanned Aerial Systems within Homeland: Security Game-Changer?" Hearing before the House Committee on Homeland Security, Subcommittee on Oversight, Investigations, and Management, *U.S. House of Representatives*, July 19, 2012, 2-5, available at: *http://fas.org/irp/congress/2012_hr/uas-homeland.pdf.*
[45] Ibid.
[46] Brad Grave, "FAA Could Clear Drones for Civilian Role," *San Diego Business Journal,* October 10, 2011.

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Amendment. Moreover, the National Security Agency's extensive intelligence gathering programs revealed by its former contractor, Edward Snowden, in 2013 added to the perception that government agencies are exercising undue power over American citizens with little regard for their constitutional rights. From this perspective, increasing government use of UAS will only aggravate the problem.

After the FMRA was enacted, civil liberties organizations, Congress, and the administration have been struggling to grasp the law's implications for these issues and identify the best way not to violate privacy and the Fourth Amendment. Initially, the FAA, as an agency whose responsibility is to ensure aviation safety, was reluctant to take part in the privacy debate.[47] However, civil liberties advocates pressured the FAA to address privacy while implementing the FMRA, and the agency changed its position and solicited comments on privacy concerns at the six testing ranges.[48]

The heart of the privacy question is less about UAS' ability to fly longer periods of time at sustained altitude than other technologies attached to them that are capable of tracking, monitoring, and recording an individual's activity. Legal precedents offer clues on how future decisions involving UAS operation might be made. Court decisions thus far indicate that photos taken from public airspace do not constitute a violation of the Fourth Amendment search and seizure clause. However, government's use of thermal imaging equipment to sense the heat signatures of marijuana growth inside of a home without a search warrant has been determined to violate the reasonable expectation of privacy. A more recent ruling in 2012 suggested that using a GPS device to track a suspect for a prolonged period of time violated the Fourth Amendment.[49] The 113th Congress introduced the "Drone Aircraft Privacy and Transparency Act of 2013" multiple times to amend the FMRA to improve privacy protection, but none of them advanced beyond referral to the relevant committees.[50]

Although privacy has been the thorniest issue related to the government use of UAS, the American public is ambivalent about the subject. They are anxious about the vague idea of government spying on people and monitoring individuals without warrant. On the other hand, there is significant support for the use of UAS for law enforcement, border patrol and emergency management. Public opinion polls well reflect these sentiments. Monmouth University surveyed public attitudes over the domestic use of UAS in 2012 and 2013. The American

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[47] Jen DiMascio and Andrew Compart, "House Lawmakers Unhappy With FAA On UAV Privacy Concerns," *Aerospace Daily and Defense Report* 244:44 (December 3, 2012).
[48] Sorcher, "What Drones Can Do For You."
[49] Daniel McGlynn, "Domestic Drones: Are unamend aircraft safe?" *CQ Researcher,* October 18, 2013, 898-9.
[50] "Current Legislative Activities," *Congress.gov*, available at: *https*://beta.congress.gov/.

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public widely supports search and rescue missions, as well as border patrol to control illegal immigration. More specifically, according to the Monmouth University surveys, four out of five respondents approved of search and rescue missions, and over 60 percent supported using UAS for border patrol. At the same time, respondents deeply worry over government's infringement on individuals' privacy.[51]

Such vacillation in the public's mind is also illuminated at the state and local level. A number of states including Florida, Idaho, Illinois, Indiana, Iowa, Montana, Oregon, Tennessee, Texas, Utah, and Wisconsin have passed laws requiring a warrant for flying drones or allowing evidence gathered by UAS.[52] Moreover, a number of communities have declared a moratorium on UAS until they further figure out the balance between advanced technology and privacy. The awareness and anxiety over government use of UAS, law enforcement in particular, will contribute to developing a legal and policy framework to mitigate abuse and the misapplication of new technologies.

On the other end of the spectrum, the advocates of UAS flights demand relaxation of regulations. One such group is journalists and the media, who contend that the existing regulation prohibiting commercial UAS flights amounts to a violation of their First Amendment rights to gather news.[53] However, a more serious concern in anticipation of opening domestic airspace to more UAS is safety.

Safety Issues

Safety is FAA's most important responsibility in the pursuit of integrating commercial UAS into the national airspace. Examination of civil aviation safety records for manned aircraft can help underscore the importance of proper regulation. According to the FAA, there are two categories of civil aviation. One is commercial aviation for air carriers, and the other general aviation.[54] While commercial aviation operation is typically thought of as passenger airliners flown

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[51] Monmouth University, "U.S. Supports Some Domestic Drone Use; But public registers concern about own privacy," June 12, 2013 and August 15, 2013.
[52] National Conference of State Legislatures, "2014 State Unmanned Aircraft Systems (UAS) Legislation," June 4, 2013, available at: *http://www.ncsl.org/research/civil-and-criminal-justice/2014-state-unmanned-aircraft-systems-uas-legislation.aspx*; "2013 Unmanned Aircraft Systems (UAS) Legislation," *National Conference of State Legislatures*, 2014, available at: *http://www.ncsl.org/research/civil-and-criminal-justice/unmanned-aerial-vehicles.aspx*.
[53] Jack Nicas, "Media Companies Say FAA Drone Rule Violates First Amendment; Group Contends 'Overly Broad Policy' Has a "Chilling Effect,"" *Wall Street Journal Online,* May 6, 2014.
[54] Department of Transportation, "FAA TV: General Aviation: The Foundation of America's Aviation System," *Federal Aviation Administration*, available at: *http://www.faa.gov/tv/?mediaId=115*.

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by large jets, this category also includes cargo operations, commuter planes, and on-demand operations such as "air taxi operations, and certain emergency medical transport operations. General aviation encompasses recreational flight, the operation of large private business jets, agricultural aircraft for aerial applications, and flight training.[55]

Large passenger airliners have shown remarkably improved safety records. The last commercial airline accident that resulted in a fatality was the crash of a Colgan Air flight near New York in 2009 killing all forty-nine onboard.[56] Nonetheless, other commercial aviation such as commuter airplanes and on demand operations suffers much higher accident rates than large commercial airliners. Even worse is the record of general aviation operations. Between 1993 and 2012, commercial airlines experienced 742 accidents in contrast to 153 for commuter airplanes, 1,303 for on demand operations, and 34,614 for general aviation. A more insightful data set is accidents per flight hours, which highlights the same point more clearly. According to National Transportation Safety Board (NTSB) statistics, general aviation operations experience 7.15 accidents per 100,000 flight hours in contrast to 0.22 for airlines. This means that the accident rate per flight hour for general aviation operations is 33 times higher than airlines. Also, commuter planes are almost seven times more likely to be involved in an accident, and on demand operations 9.6 times more likely than major airlines.[57]

Figure 1: Accidents per 100,000 flight hours, 1993-2012

[55] National Transportation Safety Board, "Review of U.S. Civil Aviation Accidents, Calendar Year 2010," 3; FAA, "FAA TV: General Aviation: The Foundation of America's Aviation System."
[56] Mike M. Ahlers, "Airline blames Buffalo-area crash on crew," *CNN,* December 14, 2009, available at: *http://www.cnn.com/2009/US/12/14/buffalo.crash.colgan.air/*.
[57] "Summary of US Civil Aviation Statistics for Calendar Year 2012," National Transportation Safety Board, September 15, 2014, available at: *http://www.ntsb.gov/data/aviation_stats.html*.

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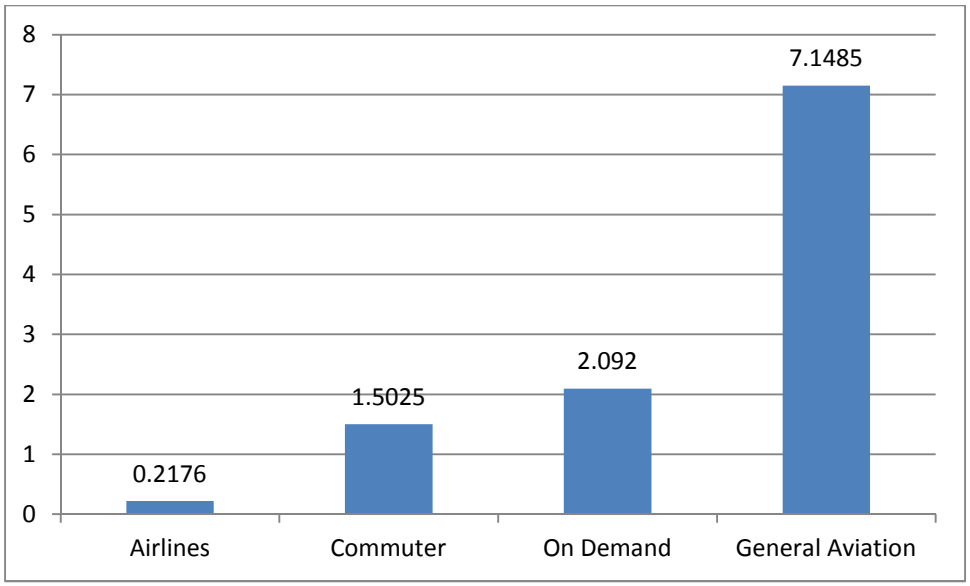

Source: National Transportation Safety Board, "2012 Aviation Statistics."

In other words, while the safety of large passenger airliners has improved, the safety of smaller aircraft, particularly those operations under the category of general aviation, has been unsatisfactory. The reasons for such a big variance among different types of civil operations are in dispute. The NTSB's investigation concludes that pilots were responsible for 86 percent of the accidents involving general aviation over the past five decades. However, a *USA Today* investigative report attributes mechanical problems as the main reason for the high rate of general aviation accidents and points blame at the manufacturers of smaller aircraft used by general operators.[58] Either way, this pattern suggests that the existing regulation for general aviation is inadequate. A higher standard of training and better oversight for general aviation pilots, as well as an updated set of safety requirements for the manufacturers of small aircraft, are deemed to be necessary.

High accident rates in general aviation have become a blind spot for aviation safety since general aviation tends to be viewed as an individual responsibility rather than a public safety matter. However, such vulnerabilities in aviation safety should not be overlooked. Aviation accidents endanger not only the safety of the operators of small aircraft but also the safety of passengers onboard and other members of the public involved in accidents.

[58] Thomas Frank, "Safety last; Lies and coverups mask roots of small-plane carnage," USA Today, 2014, available at: *http://www.usatoday.com/longform/news/nation/2014/06/12/lies-coverups-mask-roots-small-aircraft-carnage-unfit-for-flight-part-1/10405323/*.

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UAS operators and regulators alike can learn lessons from the problems of general aviation safety. In developing a comprehensive plan to integrate UAS into the national airspace, the FAA is trying to achieve such a goal in a safe manner, but accidents involving UAS are already a serious concern for some. With the growing use of UAS, the frequency of UAS incidents is increasing.

According to a *Washington Post* report, there have been over 400 accidents involving U.S. military UAVs between 2001 and 2013 worldwide. Of these, 194 cases were categorized as "Class A" accidents, denoting the most severe accidents that resulted in complete aircraft destruction or that "caused at least $2 million in damage." Of the 194 Class A accidents, at least forty-nine crashes took place in the United States. Although military UAS have been characterized as reliable, and Pentagon officials are confident in the safety of flying drones, the number of accidents involving military UAS raises questions for the safety of domestic flights as well. Some of the fundamental weaknesses of the UAS system include: human error, limited ability to detect and avoid collision, mechanical defects, and fragile communications links.[59] There also have been twenty-three non-military UAS accidents and fifteen near miss encounters reported between 2009 and the summer of 2014.[60]

Ensuring safety in UAS operations should be the top priority for the FAA in developing and finalizing rules for civilian UAS in the national airspace. Although the greatest advantage of UAS in warfare has been minimizing, if not avoiding, human loss while conducting surveillance or launching air strikes, UAS can pose a hazard to an air traffic system already crowded with manned aircraft. This is the reason behind the *Air Line Pilots Association* (ALPA)'s reservations on the idea of allowing commercial UAS. In its white paper published in 2011 when debate over commercial UAS was underway prior to the passage of the 2012 bill, ALPA asserted that introducing commercial UAS into U.S. airspace had "the potential to profoundly degrade the safety of both commercial and general aviation flight operations if this integration is not accomplished in a responsible and comprehensive manner."[61] One such concern of the ALPA was the added responsibility the air control system might have to assume. Without requiring

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[59] Amy Chow, Alberto Cuadra, and Craig Whitlock, "Hazard Above: Drone Crash Database: Fallen from the skies," *Washington Post,* June 20, 2014, available at: *http://www.washingtonpost.com/wp-srv/special/national/drone-crashes/database/, http://www.washingtonpost.com/sf/investigative/2014/06/20/when-drones-fall-from-the-sky/*.

[60] Craig Whitlock, "Hazard Above: A risky business?: Part III: Near Misses: Close Encounters on Rise as Small Drones Gain in Popularity," available at: *http://www.washingtonpost.com/sf/investigative/2014/06/23/close-encounters-with-small-drones-on-rise/*.

[61] "Unmanned Aircraft Systems: Challenges for Safely Operation in the National Airspace System," *Air Line Pilot Association*, April 2011, 3, available at: *http://www.alpa.org/portals/alpa/pressroom/inthecockpit/uaswhitepaper.pdf*.

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UAS to have transponders or other collision warning systems in the air, the presence of UAS in busy air traffic areas would further strain an air control system already under stress.[62] The association also brought attention to the quality of UAS pilots, and called for high training requirements. Even within the Department of Defense, while large military UAS such as Global Hawk and Predator are operated by highly skilled pilots, smaller UAS operations are conducted by "operators" without much aviation training.[63]

There is also a unique and difficult challenge to UAS. It is more than an aircraft. What makes UAS valuable and attractive is the connectivity between aircraft and the ground control station that allows data to be transmitted back and forth. However, this exact feature can be its greatest vulnerability if communication is lost between the operator and the unmanned aircraft. Also unique to unmanned aircraft are their inability to "see and avoid" since no pilot is onboard to scan around the aircraft. The development of "sense and avoid" technologies to overcome the problem is considered to be the most serious technical hurdle to flying UAS extensively.[64] The Department of Defense and the FAA have been in cooperation to complete the system in a couple of years.[65] Given that these technological challenges have yet to be solved, the safety of UAS flights should take precedence over meeting a congressionally mandated deadline.

The FAA should consider phased openings of domestic airspace to UAS users. The safety implications of flying agricultural UAS in a rural area or UAS operations for surveying an oil pipeline in the Arctic are profoundly different from operating UAS in a densely populated area near a major airport. It would be a prudent approach to allow commercial UAS flights first in lower risk environments such as over farmland or sea. Only after gathering sufficient data from such operations and conducting safety analyses should the FAA gradually expand commercial use of UAS into more urban areas.

Conclusion

The fast advancement of UAS technology and wide use of unmanned aerial vehicles overseas have fostered high interest and demand to take advantage of its potential, ultimately leading to the passage of the FMRA. The significance of the 2012 legislation is that Congress essentially endorsed the commercial use of UAS in the nation's airspace and broader use by public entities. The legislation is

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[62] Ibid, 6.
[63] Ibid, 3.
[64] Dillingham, "Unmanned Aircraft Systems," 14-16.
[65] Marina Malenic, "DoD to complete development on UAS sense-and-avoid systems by FY2017," *Jane's Defense Weekly,* available at: *http://www.janes.com/article/33568/dod-to-complete-development-on-uav-sense-and-avoid-systems-by-fy-2017.*

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hailed as a stepping-stone for materializing economic gains and utilizing technologies to bring social benefits such as better law enforcement and scientific studies. After the completion of a new set of regulations, the process for obtaining permits to operate UAS for governmental use is expected to be more expedient. The availability of commercial UAS is estimated to add tens of thousands of new jobs and create a multibillion market. The expansion of the UAS domestic market will also help the United States maintain its superiority in UAS technology on the global market where intense competition is already taking place, with Israel and China emerging as leading exporters.

However, not everyone is pleased with the prospect of expanded UAS operations. From early on, the growing use of UAS was accompanied by fears over possible infringement on privacy and civil liberties. Raised awareness over such anxieties in itself has been a positive force that has prompted relevant parties, be it activist organizations or government at the local and federal levels, to address the issue. Moreover, the legal precedents related to government surveillance such as using thermal imaging or GPS provide some guidance to government on the appropriate use of UAS.

Alarm has also been voiced over the potential misuse of UAS by stalkers, drug cartels, or terrorists for illicit purposes that would endanger public safety and national security. Nonetheless, such use is not an elemental problem of UAS. Rather, the challenge is that of ill-intended perpetrators abusing the technology, and should not be a reason to restrict UAS operations.

Safety issues, on the other hand, are more inherent in embracing new technology. The examination of the general aviation accidents, the GAO report, the ALPA's white paper, and the implementation of the FMRA are illuminating. General aviation suffers from high accident rates due to the lack of adequate measures to prevent human errors and acceptable safety requirements for the manufacturers of small aircraft. The practice of the Department of Defense, which has used UAS extensively, hints that operators of small UAS are not expected to undergo rigorous training. Unmanned Aircraft flown by unskilled operators in the already congested national airspace system poses safety risks. The FAA should incorporate high standards for training and human resource management to minimize human error in setting training requirements.

Another issue related to safety is systems that can strengthen the command and control between aircraft and operators on the ground, preventing airborne collisions or accidents involving the general public. These safety systems are still under development. This reality along with FAA's failure to meet deadlines for key milestones under the FMRA demonstrate that the 2015 timeline for the integration of UAS into national airspace system required by the 2012 legislation

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is overly ambitious. To ensure safe integration of UAS into domestic airspace, policy makers should first recognize that the safety issue could easily fall through the cracks, as has been the case with general aviation. The next step is commanding patience for proper technological development that can reduce accidents while resisting industry or political pressure. In the meantime, a phased opening of the national airspace for UAS in a lower risk environment, for instance over rural areas or the Artic, seems appropriate. Such gradual approaches will contribute to the safe integration of UAS.

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