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THESIS

**UNMANNED AIRCRAFT SYSTEMS FOR EMERGENCY
MANAGEMENT: A GUIDE FOR POLICY MAKERS AND
PRACTITIONERS**

by

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March 2016

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**UNMANNED AIRCRAFT SYSTEMS FOR EMERGENCY MANAGEMENT: A
GUIDE FOR POLICY MAKERS AND PRACTITIONERS**

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ABSTRACT

Responding to disasters is a critical function for first responders and the emergency management community. The primary mission when responding to disasters is saving lives, which often requires the use of multiple resources. Rotary and fixed-winged aircraft have traditionally performed disaster response missions, such as overhead damage assessments, reconnaissance, and missing person searches. However, with the advancement of unmanned aircraft systems (UASs), there is an opportunity to perform many conventional aerial missions in a safer, more expeditious, and cost-effective manner.

This thesis explores the introduction of UASs for disaster response missions into the national airspace system of the United States. It includes a review of traditional disaster response missions and opportunities for the utilization of UASs; a comparison of UAS programs, both military and civilian, as well as international UAS programs; and a review of barriers to implementation. It also offers policy and program considerations for agencies and jurisdictions to consider when implementing a UAS program, and it recommends future research concerning the topic of autonomous UASs. Lastly, this thesis provides a decision guide to assist policy makers and practitioners with determining the need and feasibility of a UAS program.

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LIST OF ACRONYMS AND ABBREVIATIONS

AED	automated external defibrillator
AEL	approved equipment list
AGL	above ground level
AIA	Aerospace Industries Association
AOPA	Aircraft Owners and Pilots Association
AOR	area of responsibility
APA	Administrative Procedures Act
ARC	air reconnaissance chief
CAP	Civil Air Patrol
CAR	Canadian Aviation Regulation
CASA	Civil Aviation Safety Authority (Australia)
CBP	Customs and Border Protection
CEO	chief executive officer
CIA	Central Intelligence Agency
COA	Certificate of Waiver or Authorization
COP	common operating picture
COTS	commercial off-the-shelf
DHS	Department of Homeland Security
DOD	Department of Defense
DSCA	Defense Support to Civil Authorities
EMA	emergency management agency
EMPG	Emergency Management Performance Grant
EOC	emergency operations center
EOP	emergency operations plan
ESF	emergency support function
FAA	Federal Aviation Administration
FDNY	Fire Department, City of New York
FEMA	Federal Emergency Management Agency
FLIR	forward looking infrared
FOIA	Freedom of Information Act

FUEGO	Fire Urgency Estimator in Geosynchronous Orbit
HazMat	hazardous materials
HSGP	Homeland Security Grant Program
IAW	in accordance with
IC	incident commander
ICP	incident command post
MSP	Michigan State Police
NAS	national airspace system
NATO	North Atlantic Treaty Organization
NOAA	National Oceanic and Atmosphere Administration
NPS	Naval Postgraduate School
NYPD	New York City Police Department
OC	operating certificate
ODOT	Ohio Department of Transportation
OSHP	Ohio State Highway Patrol
PD	police department
PIC	pilot in command
SA	situational awareness
SecDef	secretary of defense
SEOC	state emergency operations center
SFOC	Special Flight Operations Certificate (Canada)
SHSP	State Homeland Security Program
SOP	standard operating procedure
UAS	unmanned aircraft system
UASI	Urban Area Security Initiative
UAV	unmanned aerial vehicle
USCG	United States Coast Guard

EXECUTIVE SUMMARY

You don't concentrate on risks. You concentrate on results. No risk is too great to prevent the necessary job from getting done.

— Brigadier General Chuck Yeager, U.S. Air Force pilot

Emergency management is at a crossroads as it pertains to unmanned aircraft systems (UASs). Disasters provide an environment that is conducive to using UASs to support the efforts of emergency responders, yet their use is not without controversy. With the advancement of UASs, there is an opportunity to perform many conventional aerial disaster response missions in a safer, more expeditious, and cost-efficient manner.

In this thesis, the author argues the benefits of implementing UASs as a resource for emergency managers to use for mitigation, protection, response, and recovery efforts. However, the primary area of focus of this thesis is the disaster response mission area. Implementation of a UAS program, whether governmental or non-governmental, requires a significant commitment of funding and resources and warrants an in-depth review and analysis to ensure the implementation of such a program is feasible.

This thesis includes a review of traditional disaster response missions and opportunities for the utilization of UASs; a comparison of UAS programs, both military and civilian, as well as international UAS programs; and a review of barriers to implementation. It also offers policy and program considerations for agencies and jurisdictions to consider when implementing a UAS program and recommends the topic of autonomous UASs as an area for future research. Additionally, this thesis offers seven recommendations to assist emergency managers with implementing a UAS program.

RECOMMENDATIONS

1. Conduct a Feasibility Study Prior to Implementation

While there are benefits to implementing a UAS program for disaster response, agencies considering the establishment of a UAS program for disaster response missions, or any mission for that matter, should convene a feasibility study to evaluate the need for such a program. A UAS program should not be established simply for the sake of doing so or because it is perceived as the latest innovation in disaster response.

2. Program Funding

It is necessary to have a dedicated funding source, whether new or a reallocation from existing programs, to procure, implement, and sustain a UAS program. While some agencies and jurisdictions are fortunate enough to have funding in their existing budgets to allocate for a UAS program, the reality is many do not. Chapter V of this thesis offers examples of potential funding sources and current barriers impacting the use of funding from those programs. Additionally, Chapter VII advances a recommendation for the establishment of dedicated program funding.

3. Public Engagement and Education

Irrespective of its intent, whether implemented by emergency management, law enforcement, or homeland security missions, privacy concerns represent a significant barrier against the establishment of a UAS program. In order to mitigate this barrier, the author recommends the establishment of a public engagement and education program, reinforcing the benefits of using UASs for disaster response prior to the implementation of any such program.

4. Identify a Local Lead Agency for the UAS Program

For UASs to gain acceptance for their potential humanitarian benefits, the local/county emergency management agency (EMA) should be the lead agency

for a disaster response UAS program at the local level. Evidence has indicated the general public has concerns about privacy and government intrusion in relation to law enforcement and/or homeland security related UAS missions. Designating the local/county EMA as the lead agency for a disaster response UAS program can assist in mitigating or reducing many of the privacy and government intrusion concerns associated with law enforcement and/or homeland security UAS deployments.

5. Consider Establishing a State-Level UAS Center

A UAS center situated at the state level as a proponent and supporter of UAS operations would serve as a valuable resource positioned to assist private and public sector partners with the establishment of a program. Chapter VI presents the Ohio/Indiana UAS Center as a partnership model for advancing the use of UASs; with Chapter VII advancing a recommendation for the establishment of a state-level UAS center.

6. Implement an Emergency Waiver Process for Immediate Life Safety Disaster Response Missions

Due to the life safety issues involved with disaster response, there is a need to streamline the approval of emergency UAS flight operations. The current 24-hour timeframe for the issuance of an emergency Certificate of Waiver or Authorization (COA) is unacceptable and needlessly jeopardizes human lives. The question of whether a Federal Aviation Administration (FAA) liaison working with a state-level UAS center or the FAA UAS Integration Office has the authority to issue the authorization/approval is largely inconsequential, as long as the approval process is immediate. However, there must be a process in place to grant an immediate authorization to the requesting agency for life safety UAS missions.

7. Establishment of an FAA Liaison Office for Local and State Government

The final recommendation and arguably one of the most challenging to implement is the establishment of a liaison office within the FAA to work directly with local and state government agencies seeking to establish a UAS program. With a sole focus on local and state government programs, the liaison office would be able to expeditiously approve authorization requests as it would not be distracted with the management and approval of UAS operations for private sector organizations.

DECISION GUIDE

The decision whether to implement a UAS program requires an in-depth analysis and needs assessment as part of a comprehensive decision-making process. Appendix A of this thesis provides a decision guide as a resource for policy makers and practitioners to review when considering the implementation of a UAS program. The intent of the decision guide is to provide policy makers and practitioners with factors for consideration when assessing the need and feasibility for an agency or jurisdictional UAS program.

SUMMARY AND CONCLUSION

With an opportunity to be on the leading edge of the UAS revolution, it is an exciting time to be in emergency management. The author argues the field of emergency management should move forward with the establishment of UAS programs for disaster response by embracing UAS technology and the many benefits it offers for mitigation, preparedness, response, and recovery mission operations. While this thesis recognizes the necessity to regulate the use of UASs in the national airspace system (NAS), such regulation cannot stymie the implementation of UAS programs for governmental agencies, especially for programs focused on public safety functions, such as disaster response.

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Last and certainly not least, I dedicate this thesis to my parents. This program requires dedication and a strong work ethic, both of which you instilled in my siblings and me at a young age. Without these traits, I would have never had the courage to enter this program, much less complete it. I also dedicate this thesis to my granddaughter, who is my father’s namesake. She motivates me to

continue to do all I can on a daily basis to make the world a safer place for future generations.

I. INTRODUCTION

When it comes to taking risks, I believe there are two kinds of people: those who don't dare try new things, and those who don't dare miss them.

— John C. Maxwell, Author

A. PROBLEM STATEMENT

Responding to disasters is a critical function for first responders and the emergency management community. The primary mission when responding to disasters is saving lives, which often requires multiple resources. To respond as efficiently as possible, it is necessary for first responders, incident command posts (ICPs), and emergency operations centers (EOCs) to have an assessment of the impact of a disaster, including the location of survivors, a basic preliminary damage assessment, and a common operating picture (COP). While this assessment is often performed on the ground by the first arriving units, there are times when the conditions within a disaster area (e.g., size, extent of damage, environmental contamination) require an overhead assessment to gauge the impact of the disaster and/or search for survivors. Although rotary and/or fixed-winged aircraft provided by local, state, and federal agencies have traditionally accomplished these overhead assessments, unmanned aircraft systems (UASs) are less expensive, more rapidly deployed, and are safer to operate in hazardous conditions than conventional aircraft.

This exploratory thesis argues that UASs will enhance disaster response by providing first responders and emergency managers, hereafter referred to as emergency responders, with additional options when responding to various calamities. The foundation of this argument begins with a review of current and historical methods of providing aerial support for disaster response operations. This foundation serves as a means of providing a baseline recognition of traditional mission platforms. This thesis also explores various UAS programs

currently in place and offers policy and program considerations. The primary outcome of this thesis is a decision guide for policy makers and practitioners within an emergency management organization to use when assessing the need to establish a UAS program.

The topic of UASs for disaster response presents complex issues that are of significant interest to the emergency management community as evidenced by the litany of articles discussing the potential uses of UASs for disaster response missions. The determination of the criteria and content that would comprise a decision guide for an emergency management UAS program warrants graduate-level research. This level of research is necessary due to the need to identify the program and policy implications concerning their use to ensure operations are consistent with existing statutes and Federal Aviation Administration (FAA) rules and regulations. An analysis that addresses sub-questions, such as barriers to implementation, program design, training, maintenance, and privacy requirements, supports the aforementioned intent of this thesis.

Much of the existing research and information concerning UASs focuses on military, law enforcement, and homeland security missions or topics such as privacy issues regarding the broad-based integration of UASs into domestic, non-military applications. In addition, this thesis focuses on an emergency management perspective for disaster response, which is a topic representing a significant gap in the potential domestic use of UASs in the United States. This gap is an important area to explore as the mission requirements for emergency management, as well as the information collected and missions performed, vary significantly from military, law enforcement, and homeland security applications.

While there is a litany of articles discussing the potential uses of UASs for disaster response, there is a lack of significant research on the subject. This lack of research is not unique and has been observed with other emergent technologies over the past several years, including social media platforms and body cameras. In both of these cases, as well as what has occurred thus far with deploying UASs for disaster response missions, the available technology far

exceeds existing research and policy. This has often resulted in the technology either not being used or not being used to its potential.

Additionally, as a result of the lack of a national policy standard for UASs,¹ there is a need for a model or framework for emergency managers that will serve as a de facto decision guide when considering the implementation of a UAS program. Even as policies begin to emerge, there is a policy gap at the local and state levels of government that must be bridged for an emergency management UAS program, as the policy will vary significantly from military, law enforcement, and homeland security UAS policies.

To assist in outlining components and topics of consideration for a decision guide, this author analyzed potential disaster scenarios, current UAS applications, barriers to implementation, and comparative UAS programs. This level of analysis was necessary to ensure the proposed thesis topic fully explored the anticipated range of use and the framework necessary for a structured disaster response centric UAS program.

B. RESEARCH QUESTION

Effective disaster response requires the ability to meet the immediate needs of the survivors and to provide a rapid damage assessment of the impacts of the incident. As technology continues to evolve, the use of UASs should be considered as there is credible evidence that indicates they provide for a safer, timelier, and cost effective response option for disaster response than many traditional practices using conventional rotary and fixed-winged assets.² This is a

¹ Jeanie Moore, "Da Vinci's Children Take Flight: Unmanned Aircraft Systems in the Homeland" (master's thesis, Naval Postgraduate School, 2014), 3.

² "UAS Operations Most Frequently Asked Questions," Mesa County, CO Sheriff's Office, November 1, 2015, <http://sheriff.mesacounty.us/uav/>; Robin Murphy, "Drones Save Lives in Disasters, When They're Allowed to Fly (Op-Ed)," Space, accessed November 1, 2015, <http://www.space.com/30555-beginning-with-katrina-drones-save-lives-in-disasters.html>; Anuj Puri, *A Survey of Unmanned Aerial Vehicles (UAV) for Traffic Surveillance* (Tampa, FL: University of South Florida, 2005), <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.108.8384&rep=rep1&type=pdf2>.

critical observation as it reinforces the use of UASs as an operationally sound option for disaster response.

The key research question asked by this thesis is: *What are the policy and program considerations when developing a disaster response centric UAS program?* As noted previously, this is an important question as the emergency management use of UASs for responding to disasters varies significantly between traditional military, law enforcement, and homeland security missions.

C. METHODOLOGY

The research for this thesis includes a qualitative analysis of literature, a comparative analysis of programs, and policy modeling to develop a decision guide. A qualitative analysis of existing articles, research, and source documents facilitated research and analysis into identifying system design and program requirements. As part of the qualitative analysis research, the author found merit in conducting a comparative analysis of national and international UAS programs.

The comparative analysis research focuses on Australia and Canada as both nations have UAS regulations and legislation governing domestic operations similar in nature to those of the United States. In particular, Australia was selected as it was the first nation to draft laws and legislation pertaining to the use of UASs for civil operations.³ This comparison and contrast assisted in the formulation of the recommendations advanced by this thesis.

Because there is no national policy framework that can serve as a model for the development of jurisdictional plans for the use of UASs in disaster response, a policy modeling method was used to develop a decision guide for use by policy makers and practitioners when assessing the need and feasibility of a UAS program. With the ongoing development and implementation of

³ RPAS Training and Solutions, "Drone Laws in Australia: Are You Flying Your UAV / RPA Legally?," RPAS Training & Solutions, accessed August 9, 2015, <http://www.rpastraining.com.au/casr-101-uav-drone-legal-or-illegal>; James Coyne, *UAS Regulatory Developments*, Civil Aviation Safety Authority, Australia, accessed August 15, 2015, <http://goo.gl/YLOuel>.

legislative statutes and regulations, including FAA rules and regulations for use, the policy modeling method assisted with identifying key elements and criteria necessary when developing and implementing policy for a UAS program. However, to remain current, this thesis did not delve into the intricacies of local ordinances, state statutes, federal laws, executive orders, rules or regulations, as they are rapidly evolving.

Additionally, this thesis focuses on answering the research questions from a governmental use perspective and did not significantly address the private or commercial uses of UASs. To do otherwise would have significantly increased the scope of this thesis. Furthermore, large-scale UASs (e.g., Predator, Global Hawk) were not significantly reviewed as part of the research for this thesis. This was an intentional decision as the focus of this thesis is on UAS platforms that are both readily accessible by local governmental agencies and easily transported via standard departmental vehicles.

D. LITERATURE REVIEW

The literature review provides the foundation for the research of this thesis. Literature discussing past, present, and future uses for UASs, conventional aerial missions during disasters, military uses of UASs, international UAS programs, examples of domestic UAS missions performed to date, and barriers to implementing domestic UAS programs were located in a variety of sources. The source information for this thesis was obtained via a review and analysis of technical and trade journals, media articles, numerous professional association websites, governmental agency websites, published articles, published theses work, and government publications. Based on the research conducted for this thesis, the sources are sorted into five primary categories:

- Historical perspective of aerial missions for disaster response
- The expansion of UASs from military to civilian use
- Comparison of UAS programs
- Potential domestic uses of UASs for disaster response

- Barriers complicating the domestic use of UASs for disaster response

1. Historical Perspective of Aerial Missions for Disaster Response

To assist in understanding the benefits of developing a UAS program for emergency management, it is important to understand the traditional methods and platforms used for disaster response missions. A variety of source material notes the use of aerial assessments for obtaining damage estimates in the aftermath of disasters, as well as for reconnaissance and mapping purposes. For instance, Sherman Fairchild, the developer of the Fairchild Camera, performed one of the first non-military aerial assessments when mapping Manhattan, New York in 1921.⁴ Subsequent aerial missions for post-disaster damage assessments were conducted throughout the twentieth century and have continued into the twenty-first century. Examples of recent twenty-first century aerial damage assessment missions includes disasters such as the 2011 Japanese earthquake and resultant tsunami that led to the Fukushima Daiichi Nuclear Plant disaster⁵ and Hurricane Sandy in 2012.⁶ The need for aerial missions to determine the impact of disasters will continue, whether they are performed via rotary and/or fixed-winged aircraft, UASs, or satellites. Given that platforms for obtaining damage assessment information vary according to the resources that are available, recognition of the advantages offered by UASs should be considered as unmanned platforms shift from primarily a military centric focus to a more domestic role for public safety and humanitarian purposes.

⁴ Paul R. Baumann, "History of Remote Sensing, Aerial Photography," State University of New York, Oneonta, accessed September 7, 2015, <http://www.oneonta.edu/faculty/baumanpr/geosat2/RS%20History%20/RS-History-Part-1.htm>.

⁵ Brian Everstine, "Drones Play Role in Disaster Response," *Navy Times*, November 26, 2013, <http://archive.navytimes.com/article/20131126/NEWS/311260021/Drones-play-role-disaster-response>.

⁶ National Oceanic and Atmospheric Administration, "Responding to Hurricane Sandy," last modified November 9, 2012, <http://oceanservice.noaa.gov/news/weeklynews/oct12/nos-response-sandy.html>.

2. The Expansion of UASs from Military to Civilian Use

Numerous literary sources in the literature note the expanded use of UASs from primarily a military application to civilian use; however, many of these sources highlight the use of military-type UASs for civilian missions.⁷ For example, while military-type UASs have served as a valuable resource for situations such as performing radiation monitoring at the Fukushima Daiichi Nuclear Power Plant in the aftermath of the 2011 earthquake and tsunami in Japan,⁸ the realities are that the use of Department of Defense (DOD) assets—whether active duty, Reserve Component, or National Guard—for domestic disaster response within the United States involves a complicated approval process.

For example, a February 17, 2015, memo from the U.S. DOD complicates the use of military assets for civilian disaster response as the domestic use of National Guard owned UASs requires the approval of the secretary of defense (SecDef).⁹ This approval requirement can significantly delay, or eliminate, the ability of the National Guard to provide UAS support during a disaster. While such a delay or denial presents challenges, there are other options for obtaining UAS support.

Upon determination by the state emergency operations center (SEOC) that a UAS asset is required for a given mission and there are no UAS assets available within the state, a request can be made asking the federal government to provide the support, contingent upon the proper emergency declarations being in place. For the federal government to provide UAS support to local and/or state governments, assuming local officials and the governor have issued the

⁷ Everstine, “Drones Play Role in Disaster Response.”

⁸ Ibid.

⁹ U.S. Department of Defense, *Guidance for the Domestic Use of Unmanned Aircraft Systems* (Policy Memorandum 15-002) (Washington, DC: U.S. Department of Defense, 2015), http://www.defense.gov/Portals/1/Documents/Policy%20Memorandum%2015-002%20_Guidance%20for%20the%20Domestic%20Use%20of%20Unmanned%20Aircraft%20Systems_.pdf.

necessary declarations, a request is initiated through the Federal Emergency Management Agency (FEMA) to another federal agency. Requests can also be forwarded to the defense coordinating officer within one of the FEMA regional offices as a Defense Support of Civil Authorities (DSCA) mission. While DSCA support can provide critical resources to support local and state disaster response efforts, it can take a significant amount of time to assign and fulfill mission requests, as there is a requirement for the state to exhaust or exceed its resource capabilities prior to requesting DSCA support.¹⁰ Absent a lack of state resources and/or the issuance of an emergency or disaster declaration, DSCA support via active duty DOD assets is limited.

While the UAS assets maintained by the DOD have exceptional video and air monitoring capabilities, similar technologies are available on civilian platforms that are much smaller, less expensive, and more easily transported.¹¹ This is but one example that supports the efficacy of disaster response centric UAS programs for local and state government agencies.

3. Comparison of UAS Programs

As there are over 50 nations deploying UASs for military purposes alone,¹² this thesis reviews literature pertaining to international UAS programs and UASs for military applications. The research on international programs focuses on Australia, Canada, and the United States due to similarities in the government oversight of domestic UASs within these nations.

¹⁰ Office of the Assistant Secretary of Defense/Homeland Defense and America's Security Affairs, *Department of Defense Support to Domestic Incidents*, Federal Emergency Management Agency, January 2008, http://www.fema.gov/pdf/emergency/nrf/DOD_SupportToDomesticIncidents.pdf.

¹¹ Carol Kuruvilla. "Photos: High-Tech Drones Find Non-War, Civilian Uses," *NY Daily News*, February 21, 2013, <http://www.nydailynews.com/news/national/photos-high-tech-drones-find-non-war-civilian-article-1.1270332>.

¹² "The Drones of War," *Strategic Comments* 15, no. 4 (2009): 1–2, doi: 10.1080/13567880903040825.

Australia prides itself on being the first nation to have enacted legislation governing the use of UASs for domestic missions.¹³ Australia's Civil Aviation Safety Authority (CASA) is responsible for providing the safe regulation of domestic flight operations in Australia.¹⁴ Similar to Australia's CASA, the regulation of UASs in Canada is administered by Transport Canada for civilian use and by the Canadian Department of National Defence for military applications.¹⁵ Lastly, the FAA is tasked with providing a safe and efficient national airspace system (NAS) for the continental United States.¹⁶ Literature reviewed for this thesis explores these comparative programs to offer a comparison and contrast of the UAS programs in those nations, thereby assisting with the formulation of the recommendations offered by this thesis.

4. Potential Domestic Uses of UASs for Disaster Response

The potential use of UASs for disaster response warrants research to identify the program and policy implications of using UASs for disaster response missions. Research on recent disasters, such as a landslide in Oso, WA, flooding in South Carolina and Wyoming, wildfires in California and Yosemite National Park, and an April 2015 earthquake in Nepal, are situations where UASs have been or potentially could have been used.¹⁷ Aside from disaster response missions, preparedness missions, such as agricultural and infrastructure inspections, wide-area mapping for geographic information system applications,

¹³ RPAS Training and Solutions, "Drone Laws in Australia."

¹⁴ Civil Aviation Safety Authority, "About CASA," accessed February 9, 2016, <https://www.casa.gov.au/standard-page/about-casa>.

¹⁵ Office of the Privacy Commissioner of Canada, "Drones in Canada," November 21, 2013, https://www.priv.gc.ca/information/research-recherche/2013/drones_201303_e.asp#heading-004-1.

¹⁶ Federal Aviation Act of 1958, Pub. L. No. 85-726 (1958).

¹⁷ Everstine, "Drones Play Role in Disaster Response;" Robin Murphy, "Oso, Washington Mudslides: We Had the UAVs There but Didn't Fly," last modified April 1, 2014, Crasar, <http://crasar.org/2014/04/01/oso-washington-mudslides-we-had-the-uavs-there-but-didnt-fly/>; Brent Klavon, "Why We Need Drones," *The Gainesville Sun*, last modified December 2, 2013, <http://www.gainesville.com/article/20131202/OPINION/131209953?p=1&tc=pg>.

and commodity flow studies, represent areas of disaster readiness and preparedness that would benefit from the use of UASs.

While the terms drone and UAS are commonly associated with military-type platforms, there is an emergent philosophy favoring smaller or micro UASs, which can be transported in a vehicle. Small or micro UASs offer a rapidly deployable option that is less expensive to operate in comparison to military-type UASs and traditional rotary or fixed-winged assets.¹⁸ One example of the use of small or micro-sized UASs was at the 2011 Fukushima Daiichi Nuclear Plant accident in Japan where 40 missions were flown over a three-month period from April to July 2011 “in order to conduct radiological surveys, visual damage assessment for structural integrity monitoring, and debris removal forecasts.”¹⁹ This type of structural integrity and environmental monitoring is critical in establishing an on-scene assessment prior to committing resources downrange in a contaminated environment and to assist incident command staff in making personal protective equipment and population protective action decisions.

The author reviewed Naval Postgraduate School (NPS) theses written by Moore and Wallace to determine the need for additional academic work related to disaster response missions for UASs. While Moore’s thesis addresses the use of UASs in the homeland, it primarily focuses on “an orientation to the key considerations in UAS integration.”²⁰ In contrast, Wallace’s thesis focuses on “possibilities and advantages of incorporating the use of [UAS] into operational use by local public safety agencies.”²¹ While both theses are well researched

¹⁸ Heather Kelly, “Drones: The Future of Disaster Response,” *CNN*, May 23, 2013, <http://www.cnn.com/2013/05/23/tech/drones-the-future-of-disaster-response/index.html>.

¹⁹ Brittany A. Duncan, and Robin R. Murphy, “Autonomous Capabilities for Small Unmanned Aerial Systems Conducting Radiological Response: Findings from a High-Fidelity Discovery Experiment: Autonomous Capabilities for SUAS Conducting Radiological Response,” *Journal of Field Robotics* 31, no. 4 (2014): 522–536, doi:10.1002/rob.21503.

²⁰ Moore, “Da Vinci’s Children Take Flight.”

²¹ John A. Wallace, “Integrating Unmanned Aircraft Systems into Modern Policing in an Urban Environment” (master’s thesis, Naval Postgraduate School, 2012).

and written, neither specifically examined the potential emergency management uses of UASs.

A thesis by Momont takes a different perspective from that of Moore and Wallace. Momont primarily reviews the potential use of UASs when responding to emergencies or disasters, though he also references general public safety response operations. One novel concept Momont addresses is the deployment of an “ambulance drone” to respond to situations necessitating the use of an automated external defibrillator (AED).²² By expanding the use of UASs to serve in an operational capacity, such as an “ambulance drone,” AEDs, first-aid kits, and prescription medications could arguably be provided faster than traditional ground transportation methods. Additionally, an “ambulance drone” could provide access to areas that would otherwise be temporarily inaccessible to emergency personnel in the aftermath of a disaster (e.g., collapsed buildings, flood zones).

Further research identified a process outlined by Quaritisch et al. that not only provides video of a disaster area via a UAS platform but introduces the concept of an aerial sensor network via multiple UASs for achieving a comprehensive COP of the environment.²³ This type of UAS network could be very helpful, for example, in the case of geo-mapping and wide area searches for missing persons.

5. Barriers Complicating the Domestic Use of UASs for Disaster Response

The author’s research reveals numerous barriers that complicate the use of UASs for disaster response, including public perception (i.e., privacy concerns), current FAA rules and regulations, and a general lack of organizational policy structures. While none of these areas are insurmountable,

²² Alec Momont, “Drones for Good” (master’s thesis, Technical University of Delft, 2014).

²³ Markus Quaritisch et al., “Networked UAVs as Aerial Sensor Network for Disaster Management Applications,” *e & i Elektrotechnik und Informationstechnik* 127, no. 3 (2010): 56–63.

they nonetheless represent challenges for agencies considering the use of UASs within the United States.

Privacy concerns have been raised that the domestic use of UASs may infringe upon the right to privacy afforded under the Fourth Amendment to the U.S. Constitution. Recognizing public concerns about the use of UASs to conduct domestic spy missions, the U.S. Department of Homeland Security (DHS) has proactively assigned the Office for Civil Rights and Civil Liberties and the Privacy Office to lead a working group ensuring the domestic use of UASs does not violate individual rights to privacy.²⁴ The Obama administration has taken this a step further through the issuance of a presidential memorandum that recognizes the need to promote innovation and “economic competitiveness” regarding the domestic use of UAVs [UASs] while at the same time providing protections for privacy, civil rights, and civil liberties.²⁵ This memorandum reinforces the necessary linkage between innovation, privacy, and civil liberties. These critical areas are further addressed and analyzed in Chapter V of this thesis.

Another potential barrier concerning the domestic use of UASs is based on ethical considerations. These concerns go beyond the apprehension expressed in Oso, WA, for example, in the aftermath of the March 2014 landslide wherein there were concerns that pictures of the deceased would be publicly accessible.²⁶ Gilman provides an interesting observation as he opines, “The military remains the largest user of UAVs [UASs], while the manufacturers are primarily military contractors. This situation raises ethical and operational considerations for humanitarian organizations, who may not wish to be

²⁴ Julie Bird, “DHS Seeks to Head off Domestic UAV Privacy Concerns,” *FierceGovernmentIT*, February 25, 2013, <http://www.fiercehomelandsecurity.com/story/dhs-seeks-head-domestic-uav-privacy-concerns/2013-02-25>. <http://www.fiercegovernmentit.com/story/dhs-seeks-head-domestic-uav-privacy-concerns/2013-02-25>.

²⁵ “Promoting Economic Competitiveness While Safeguarding Privacy, Civil Rights, and Civil Liberties in Domestic Use of Unmanned Aircraft Systems,” press release, Office of the Press Secretary, White House, February 15, 2015, <https://www.whitehouse.gov/the-press-office/2015/02/15/presidential-memorandum-promoting-economic-competitiveness-while-safegua>.

²⁶ Murphy, “Oso, Washington Mudslides: We Had the UAVs.”

associated even indirectly with military actors.”²⁷ While Gilman’s opinion is recognized, further research (see Chapter V) has failed to locate sufficient evidence to support Gilman’s assertion.

Yet an additional barrier that complicates the use of UASs for disaster response missions are the FAA restrictions on the use of UASs by government agencies. While there are processes for emergency requests, research indicates the typical turnaround time to obtain a non-emergency Certificate of Waiver or Authorization (COA) for government agency UAS use is approximately 60 days.²⁸ Even with a one-time emergency waiver, the timeframe required to obtain a COA is mission prohibitive for real-time response to disasters and presents a significant barrier to those agencies that may be interested in using UASs for immediate disaster response missions.

Research on FAA regulations pertaining to the government use of UASs found the release of guidance for law enforcement agencies on January 8, 2015, concerning the unauthorized use of UASs,²⁹ and additional guidance on February 15, 2015, which outlines the use of small UASs.³⁰ However, the February 2015, small-UAS rule does not apply to government use “unless the operator opts to comply with and fly under the new small UAV [UAS] regulations.”³¹ As such, the current small UAV (or UAS) regulations are not practical for disaster response missions as they prohibit flying a UAS over people.³² This prohibition eliminates one of the key missions when responding to

²⁷ Daniel Gilpin, *Unmanned Aerial Vehicles in Humanitarian Response*, ed. Matthew Easton (New York: United Nations Office for the Coordination of Humanitarian Affairs, 2014), 9.

²⁸ Federal Aviation Administration, *Fact Sheet—Unmanned Aircraft Systems (UAS)*, last updated March 2015, https://www.faa.gov/uas/faq/media/1009_UAS_Fact_Sheet.pdf.

²⁹ Federal Aviation Administration, “FAA Issues UAS Guidance for Law Enforcement,” January 8, 2015, <https://www.faa.gov/news/updates/?newsId=81244>.

³⁰ Operations and Certification of Small Unmanned Aircraft Systems, 14 C.F.R. §21, 43, 45, 47, 61, 91, 101, 107, and 183 (2015).

³¹ Federal Aviation Administration, “DOT and FAA Propose New Rules for Small Unmanned Aircraft Systems,” news release, February 15, 2015, http://www.faa.gov/news/press_releases/news_story.cfm?newsId=18295.

³² *Ibid.*

disasters, which requires UASs to potentially fly over people on the ground when locating survivors.

In an effort to address public concerns, a 60-day public comment period on the new small UAS rule closed in April 2015 and comments are still going through the adjudication process as of the date of this thesis. Until such time an adjudication of those comments occurs and revised rules are released, current FAA regulations remain in effect.³³ A review and vetting of all public comments related to the new UAS rules is required by the Administrative Procedure Act (APA),³⁴ which will further delay the issuance of new UAS procedures.³⁵ Even once the new rules are approved, Nicas and Pasztor note the implementation of any new rules could take upwards of two years,³⁶ which is of further concern as there have already been significant delays in the release of commercial and public agency regulations and guidance by the FAA.³⁷ Any further delays in issuing updated guidance are unacceptable as they further limit the ability of governmental agencies to deploy UASs during times of disaster; however, it is recognized that the APA process is partially responsible for the delays in issuing updated UAS guidance.

³³ Ibid.

³⁴ Administrative Procedure Act, Pub. L. No. 79-404, 60 Stat. 237, 79th Cong. (1946).

³⁵ Ibid.

³⁶ Jack Nicas, and Andy Pasztor, "Drone Flights Face FAA Hit," *Wall Street Journal*, November 24, 2014, <http://www.wsj.com/articles/drone-flights-face-faa-hit-1416793905>.

³⁷ Separate but related to the public and private use of UASs, the FAA issued guidelines on December 21, 2015, requiring the registration of small UASs weighing between 0.55 and 55 pounds. As with any aircraft, the penalty for failing to register is punishable by "civil penalties up to \$27,500." Criminal penalties for failing to register "can include fines of up to \$250,000...and/or imprisonment up to 3 years." Registration and Marking Requirements for Small Unmanned Aircraft, *Fed. Reg.* 80 (2015) (codified at 14 C.F.R. pt. 1, 45, 47, 48, 91, and 375).

II. HISTORICAL AND CURRENT PERSPECTIVES FOR AERIAL PLATFORMS SUPPORTING DISASTER RESPONSE MISSIONS

To know your future, you must know your past.

— George Santayana, philosopher

The need for practitioners to educate policy makers as they develop new policies or programs (e.g., for the use of UASs in disaster response) necessitates an understanding of historical and current disaster response operations to develop a common framework from which to work. Once a common framework is established, research and evidence are allied to strengthen the position posited by the practitioner. This ultimately leads to a comprehensive analysis outlining the benefits of a given policy or program change. In the case of considering the benefits of UAS use in disaster response missions, it is also important to identify the information needs that drive the need for operational support from aerial assets.

A. INFORMATION NEEDS DURING DISASTER RESPONSE AND RECOVERY

Regardless of the type of disaster or its scope (e.g., life safety, storm location/path, duration, geographic impact), there are inherent information needs. One of the first information needs is a confirmation of the impact and extent of damage resulting from the disaster. For incidents such as earthquakes, tornadoes, hurricanes, and flash flooding, the need to expeditiously locate survivors is critical and warrants immediate access to resources that can assist in locating and guiding emergency responders to their location to initiate rescue efforts.

Once life safety measures have commenced, the magnitude of the disaster must be determined to guide the formation of a COP to assist in determining incident priorities and initial mission assignments. A key component

to the development of a comprehensive COP is having situational awareness (SA) of the incident. Though it has been superseded, the 2008 *National Response Framework* (NRF) describes situational awareness as the “ability to identify, process, and comprehend the critical information about an incident... Situational awareness requires continuous monitoring of relevant sources of information regarding actual incidents and developing incidents.”³⁸ For the purposes of this thesis, essential elements of information from the SA can include, but are not limited to, the location of survivors, preliminary damage assessments, environmental monitoring, geologic monitoring (e.g., for landslides), aerial photographs and video, status of roadways for response units, and potential hazards.

This SA must then be shared to form a comprehensive COP, which is defined in the FEMA *National Incident Support Manual* as “a shared situational awareness that offers a standard overview of an incident and provides incident in a manner that enables incident leadership and any supporting agencies and organizations to make effective, consistent, coordinated, and timely decisions.”³⁹ The need for SA and a comprehensive COP often warrant the need for aerial assessments, monitoring, and search capabilities that have been provided by a variety of conventional platforms, including rotary and fixed-winged aircraft and satellites.

B. HISTORICAL AERIAL SUPPORT FOR MILITARY AND CIVILIAN ASSESSMENT MISSIONS

Determining the impact of a disaster is critical for emergency responders as they need an accurate assessment of damage in order to respond sufficiently to rescue survivors and stabilize a given incident. Prior to the use of aircraft and satellites for obtaining damage assessments, visual images of disaster damage

³⁸ U.S Department of Homeland Security, *National Response Framework* (Washington, DC: U.S Department of Homeland Security, 2008), 32.

³⁹ U.S Department of Homeland Security, *FEMA National Incident Support Manual* (Washington, DC: U.S Department of Homeland Security, 2011), 21.

were typically captured at ground level. Even in present day emergency response, the initial, on-scene assessment of an emergency or disaster is often captured from the ground level. While the information gathered from the ground level is helpful, a more comprehensive assessment is necessary. To accomplish this assessment, first responders and emergency managers have traditionally relied on rotary and fixed-winged aircraft to perform overhead assessments of disaster areas.

Aerial assessments via fixed-winged aircraft date to the early twentieth century for missions such as the mapping of Manhattan⁴⁰ and include the more recent combined use of Civil Air Patrol (CAP) and the National Oceanic and Atmosphere Administration (NOAA) assets to capture the damage sustained by over 35,000 properties as a result of Hurricane Sandy.⁴¹ Additionally, the use of satellites for damage assessments has proven to be a valuable tool during recent disasters, such as the April 2015 7.8 magnitude earthquake in Nepal. However, as with the cost for rotary and fixed-winged aircraft support, the cost for satellite imagery can be expensive and is not readily accessible for time-sensitive missions, such as locating survivors of flash flooding or a building collapse. Furthermore, there can be a significant, if not complete, degradation of the quality of the satellite imagery due to building obstructions and cloud, fog, or smoke cover.

While the use of UASs for aerial assessments may be thought of as a recent trend, their use has a long and storied past. One of the earliest historical observations of drone or UAS use was on August 22, 1849, by Austria for an attack on Venice using 200 pilotless balloons. The first use of a UAS or drone type of vehicle in the United States dates back to the Civil War, which saw the rudimentary use of unmanned balloons for reconnaissance and bombing

⁴⁰ Baumann, "History of Remote Sensing, Aerial Photography."

⁴¹ National Oceanic and Atmospheric Administration, "Responding to Hurricane Sandy."

missions. This use expanded during the Spanish-American War with what would become the first aerial reconnaissance photos.⁴²

Further UAS use occurred during World War I, World War II, and the Cold War. In addition, the Vietnam War saw extensive use of UASs with over 34,000 surveillance missions conducted between 1964 and 1975.⁴³ After the terror attacks of September 11, 2001, the use of modern-day UASs made the transition from a reconnaissance platform to an offensive weapons-based military platform with their debut as an armed platform in Afghanistan approximately four weeks later.⁴⁴ The subsequent use of UASs for offensive military purposes by the Central Intelligence Agency (CIA), U.S. armed forces and North Atlantic Treaty Organization (NATO) allies continues in Afghanistan, Iraq, Libya, Pakistan, Somalia, Syria, and Yemen.⁴⁵ This use has served to shape the public perception of UASs and presents challenges when considering domestic UAS applications in not only the United States but other nations as well.

Evidence of the connotations and hurdles related to the domestic use of UASs is reinforced by polls such as one conducted by Monmouth University that noted while 83 percent of those polled approve of the use of UASs for missions such as search and rescue missions, 51 percent doubt that law enforcement agencies would use them appropriately.⁴⁶ This perception continues to present challenges for public safety agencies and needs addressed via a public information strategy that will instill confidence and trust in the eyes of the public concerning the domestic use of UASs.

⁴² "History of U.S. Drones," Understanding Empire, accessed August 21, 2015, <https://understandingempire.wordpress.com/2-0-a-brief-history-of-u-s-drones/>.

⁴³ Ibid.

⁴⁴ Ibid.

⁴⁵ "History of U.S. Drones," Understanding Empire; Chris Cole, "Drones in Iraq and Syria: What We Know and What We Don't," Drone Wars, July 11, 2014, <http://dronewars.net/2014/11/07/drones-in-iraq-and-syria-what-we-know-and-what-we-dont/>.

⁴⁶ Monmouth University, *National: U.S. Support Unarmed Drones* (Monmouth University, West Long Branch, NJ: 2013), <http://goo.gl/PPSkpQ>.

C. CURRENT AERIAL ASSESSMENT MISSIONS

Focusing at the local and state levels of government, rotary and fixed-winged aircraft currently provide the majority of disaster response and recovery aerial assessments of disaster areas for emergency managers. For example, in the state of Ohio, aerial support at the state level and/or in support of local communities is a mission supported through the SEOC in accordance with the *Aviation Support Plan Annex* to the “Emergency Support Function (ESF)-1” portion of the *State of Ohio Emergency Operations Plan* (EOP).⁴⁷ For incidents such as a flash flood, the Ohio State Highway Patrol (OSHP) can deploy aircraft with forward looking infrared (FLIR) capabilities to search for survivors. Other aerial missions that can be performed include damage assessments, transportation of confirmation test samples (e.g., harmful algal bloom) for water systems, and senior official flight missions to areas impacted by disasters.

Many jurisdictions have used rotary-winged aircraft during disasters for search and rescue operations, water rescue operations, and to deliver food, water, equipment, and other essentials to areas they were not able to reach via other means.⁴⁸ While missions such as those mentioned above have been performed successfully; there are inherent risks associated with using rotary and fixed-winged assets, as evidenced in the recent crash of a helicopter rendering post-earthquake disaster relief in Nepal.⁴⁹ The use of UASs for disaster response has the potential to reduce these risks.

⁴⁷ Ohio Emergency Management Agency, *Emergency Operations Plan: Emergency Support Function 1, Aviation Support Plan* (Columbus, OH: Ohio Emergency Management Agency, 2013), http://ema.ohio.gov/Documents/Ohio_EOP/ESF%20-%20-%20Aviation%20Support%20Plan%20-%20Tab%20A.pdf.

⁴⁸ Tennessee Department of Safety and Homeland Security, “Tennessee Highway Patrol’s Aviation Unit Trains for Emergency Response Missions,” Tennessee Department of Safety and Homeland Security, March 12, 2014, <https://www.tn.gov/safety/news/4985>; Todd Unger, “National Guard Chopper Crew Recounts Water Rescues,” *WFAA*, May 12, 2015, <http://www.wfaa.com/story/news/local/denton-county/2015/05/12/national-guard-chopper-crews-recount-water-rescues/27157795/>.

⁴⁹ Adam Chandler, “A Marine Helicopter Crash in Nepal,” *The Atlantic*, May 15, 2015, <http://www.theatlantic.com/international/archive/2015/05/a-marine-helicopter-crash-in-nepal/393425/>.

However, many missions (e.g., rescue operations, delivery of food and equipment) require rotary and fixed-winged aircraft in lieu of a small UAS due the extent and weight of the payload they are able to carry. Even many non-heavy lift missions, such as obtaining SA when developing a COP, have been traditionally performed by rotary and fixed-winged assets. While effective, rotary and fixed-winged assets are expensive to operate and maintain. For example, the estimated hourly cost to operate a UH-60 Blackhawk helicopter is approximately \$5,897, while the cost for law enforcement agencies to operate a single-engine, fixed-winged aircraft is approximately \$200 per hour, not counting staff cost.⁵⁰ These costs are considerable and can be minimized by deploying UASs for those missions not requiring heavy-lift aircraft.

Another existent source for aerial reconnaissance is the CAP. The CAP is the official auxiliary of the U.S. Air Force and has served the United States during disasters since World War II. One of the primary missions of the CAP is to assist with air and ground search and rescue and disaster relief operations.⁵¹ The CAP was recently deployed to provide assistance due to major flooding that occurred as a result of Hurricane Joaquin in South Carolina in October 2015.⁵² During this response, the CAP assisted with assessing damage to roadways, bridges, and infrastructure that was otherwise inaccessible by land while also assisting with search and rescue missions.⁵³ While the CAP maintains operational control of

⁵⁰ U.S. Government Accountability Office, *Border Security: Observations on Costs, Benefits, and Challenges of a Department of Defense Role in Helping to Secure the Southwest Land Border: Hearings Before the Subcommittee on Border and Maritime Security, Committee on Homeland Security, Statement of Brian J. Lepore* (Washington, DC: U.S. Government Accountability Office, 2012); Max A. Cherney, "Airborne Traffic Enforcement Practically a Thing of the Past," *San Francisco Examiner*, May 28, 2013, <http://archives.sfexaminer.com/sanfrancisco/airborne-traffic-enforcement-practically-a-thing-of-the-past/Content?oid=2349908>.

⁵¹ United States Air Force, "Factsheets: Civil Air Patrol," January 23, 2009, <http://web.archive.org/web/20101203103225/http://www.af.mil/information/factsheets/factsheet.asp?id=163>.

⁵² Lydia Ramsey, "Insane Footage of South Carolina Flooding Caused by Hurricane Joaquin," *Business Insider*, October 5, 2015, <http://www.businessinsider.com/south-carolina-flooding-hurricane-joaquin-2015-10>.

⁵³ Ibid.

their staff during mission deployments, they typically are an asset organized under ESF-1 in the SEOC.

The CAP provides coverage in all 50 states, the District of Columbia, Puerto Rico, and the Virgin Islands⁵⁴ and can be activated at the request of the SEOC for local and state missions. The process for activating the CAP typically begins with a representative from the SEOC contacting the CAP alert officer or other designee to request mission support.⁵⁵ As with the previous aircraft examples provided, there is a significant cost associated with CAP missions as the operational costs per hour were reportedly in excess of \$130 per hour in 2008.⁵⁶ While the cost for CAP support is less than many current aerial support packages, it still represents a significant cost to the taxpayer.

As previously noted, this thesis posits that an emergency management UAS program would enhance disaster response capabilities by providing emergency managers with additional options when coordinating the response to disasters. While a UAS program would not eliminate the need for other types of platforms, UAS deployments for missions such locating survivors, performing preliminary damage assessments, and environmental monitoring, offer emergency managers a safe and cost-effective resource that can be deployed more expeditiously than many traditional options.

⁵⁴ Civil Air Patrol National Headquarters, *Introduction to Civil Air Patrol* (Maxwell Airforce Base, AL: Civil Air Patrol National Headquarters, 2013), 2.

⁵⁵ Ohio Emergency Management Agency, *Emergency Operations Plan*, 1–8.

⁵⁶ Civil Air Patrol National Headquarters, *Report to Congress 2008* (Maxwell Airforce Base, AL: Civil Air Patrol National Headquarters, 2008), http://www.capmembers.com/media/cms/2008_4EBF9170D4D9A.pdf, 7.

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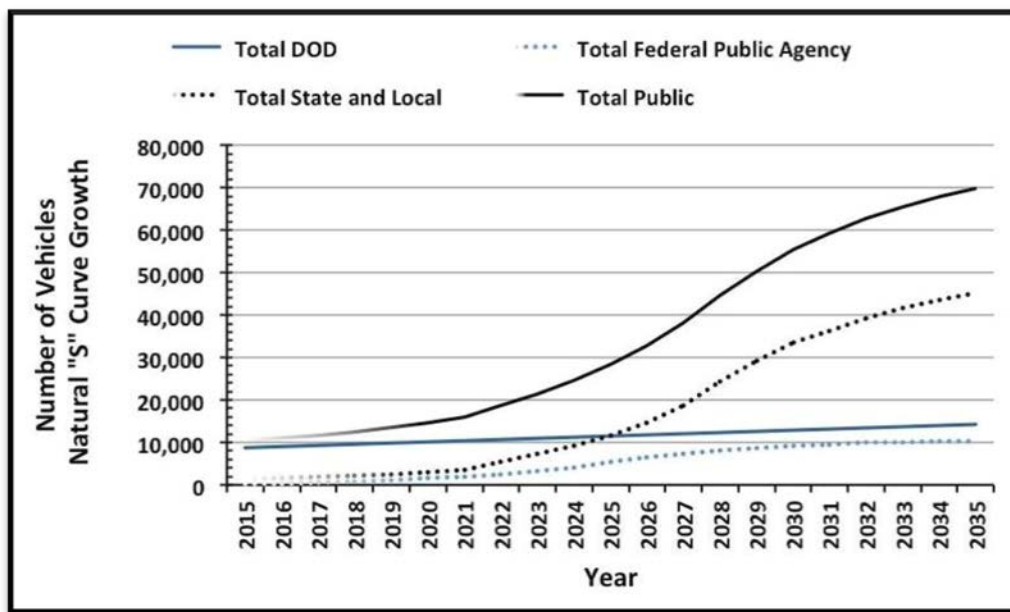
III. COMPARISON OF UAS PROGRAMS

An investment in knowledge pays the best interest.

— Benjamin Franklin, founding father, author

With the number of public agency UASs expected to balloon in the near future (see Figure 1), a comparison of existing UAS programs is necessary to assist in determining which elements of these programs may have cross-system applicability for disaster response missions.

Figure 1. DOD and Public Agency UAS Projected Use 2015–2035



Source: U.S. Department of Transportation, *Unmanned Aircraft System (UAS) Service Demand 2015–2035* (Cambridge, MA: John A. Volpe National Transportation Systems Center, 2013), 6.

A. MILITARY SPECIFIC MISSIONS

The use of UASs has traditionally had a military connotation given the prevalence of their deployment in numerous military-centric operations, and their modern-era use essentially beginning with the use of the Predator under the

CIA's Lofty View program in 1994. Under the Lofty View program, the CIA used the GNAT-750 UAS to provide surveillance for NATO convoys and to locate Serbian artillery.⁵⁷ These deployments were the first of what would become an extensive UAS program for the U.S. government.

Six years later in 2000, MQ-1 Predators were deployed to eastern and southern Afghanistan to search for Osama Bin Laden. The CIA's first reported targeted killing operation occurred approximately two years later in February 2002 with the targeting in Afghanistan of a person suspected to be Bin Laden.⁵⁸ This mission represents a starting point for a significant increase in offensive UAS operations by the United States. The use of UASs for military purposes has continued to expand with the number of UAS strike missions flown under the Obama administration numbering nearly 500 as of October 2015.⁵⁹ Even so, military UAS missions have not been solely offensive in nature as they continue to be deployed for multiple types of missions (e.g., reconnaissance).

The military also deploys UASs for intelligence, surveillance, and reconnaissance missions, including determining the location of improvised explosive devices and other hazards.⁶⁰ These missions have traditionally been accomplished by UAS platforms such as the MQ-1 Predator, MQ-9 Reaper, and the RQ-4 Global Hawk, which are flown from locations around the world, including the continental United States (see Figure 2).⁶¹ While the CIA and U.S.

⁵⁷ Ian G. R. Shaw, "Predator Empire: The Geopolitics of US Drone Warfare," *Geopolitics* 18, no. 3 (2013): 538.

⁵⁸ Ibid.

⁵⁹ Jack Serle, and Abigail Fielding-Smith, "Monthly Drone Report: Total Drone Strikes under Obama in Pakistan, Somalia and Yemen Now 491 after September Attacks," The Bureau of Investigative Journalism, October 5, 2015, <https://www.thebureauinvestigates.com/2015/10/05/monthly-drone-report-total-drone-strikes-under-obama-in-pakistan-somalia-and-yemen-now-491-after-september-attacks/>.

⁶⁰ Jason Brown, *Strategy for Intelligence, Surveillance, and Reconnaissance* (Montgomery, AL: Air University Press, 2014), http://www.au.af.mil/au/aupress/digital/pdf/paper/ap_2014-1_brown_strategy_intelligence_surveillance_reconnaissance.pdf, 2.

⁶¹ U.S. Government Accountability Office, *Air Force Actions Needed to Strengthen Management of Unmanned Aerial System Pilots* (GAO-14-316) (Washington, DC: U.S. Government Accountability Office, 2014), <http://gao.gov/assets/670/662467.pdf>.

Air Force have performed the majority of UAS missions, the DOD is planning to assign a significant number of UAS missions to the U.S. Army due to expanding mission requests and requirements.⁶² The expansion of UAS mission assignments to the Army is significant as it indicates a plan for the continued, if not expanded, deployment of UASs in support of DOD missions.

Figure 2. Operational and Training Locations for U.S. Air Force UASs



Source: U.S. Government Accountability Office, *Air Force Actions Needed*.

While military UASs provide a critical resource at no cost to local and state governments, the timeframe to obtain UAS support from DOD assets, as noted previously, can be a lengthy process requiring a DSCA mission request to FEMA. While this process can proceed fairly rapidly, there is still be a significant delay in obtaining federal or military UAS support due to the time to initiate the mission request, mobilize, and deploy the resource, and for it to become operational on location. An expansion of DOD mission requests due to evolving operations in

⁶² Andrew Tilghman, "Army, SOCOM to Take on Daily Drone Missions," *Military Times*, August 17, 2015, <http://www.militarytimes.com/story/military/pentagon/2015/08/17/daily-drone-expansion/31855831/>.

the Middle East and Africa may also limit the availability of DOD UAS assets due to in-theater mission requirements outside the United States.⁶³ While this void can potentially be filled by state National Guard UASs, the aforementioned February 17, 2015, memo from the DOD complicates the use of military assets for civilian disaster response because the domestic use of National Guard owned UASs requires the approval of the SecDef.⁶⁴ This limits the ability of the state adjutant generals to order the immediate activation of a UAS(s) to support mission requests for aerial support from an SEOC. While the resource may be available more expeditiously than going through the DSCA process via FEMA and U.S. Northern Command, the requirement for SecDef approval prior to mission tasking and deployment significantly delays the use of National Guard controlled UAS assets within a given state.

B. HOMELAND SECURITY AND LAW ENFORCEMENT MISSIONS

The U.S. Customs and Border Protection (CBP), which is the largest law enforcement agency within the DHS, first tested UASs for border patrol operations in 2004 with the first mission deployment of a CBP Predator UAS occurring in 2006.⁶⁵ As of September 2013, the CBP fielded a fleet of 10 UASs to assist in patrolling more than 7,000 miles of land border and over 95,000 miles of maritime border, which is patrolled in collaboration with the U.S. Coast Guard (USCG).⁶⁶ Between 2011 and 2014, the UASs operated by the CBP logged over 18,000 hours with approximately 80 percent of those hours occurring along border areas. The remaining flight hours during this timeframe were for training, transit, and disaster response missions.⁶⁷ These numbers represent a robust

⁶³ Ibid.

⁶⁴ U.S. Department of Defense, *Guidance for the Domestic Use*.

⁶⁵ Arthur Holland Michel, "Customs and Border Protection Drones," Center for the Study of the Drone, January 7, 2015, <http://dronecenter.bard.edu/customs-and-border-protection-drones/>.

⁶⁶ U.S. Department of Homeland Security, *Privacy Impact Assessment for the Aircraft Systems* (Washington, DC: U.S. Department of Homeland Security, 2013).

⁶⁷ U.S. Government Accountability Office, *Unmanned Aerial Systems: DHS's Review of U.S. Customs and Border Protection's Use and Compliance with Privacy and Civil Liberty Laws and Standards* (Washington, DC: U.S. Government Accountability Office 2014).

program that provides critical support to not only ground-based units operating along the border but local law enforcement and emergency management agencies as well.

A UAS program the size of CBP's is not free of controversy, including privacy trepidations over surveillance and collection operations as well as concerns about operational costs. While research did not indicate this as a conscious decision related to privacy, CBP operates its UASs at altitudes of between 19,000 and 28,000 feet, which prevents the identification of individuals or license plates.⁶⁸ It is also important to note the UASs operated by CBP "do not have the capability [authority] to collect images from non-public areas, such as the interior of homes or businesses, or otherwise perform observations that would be considered a search under the Fourth Amendment of the Constitution."⁶⁹ Even though the CBP UASs assisted in the apprehension of 2,525 people in 2013, as well rendered assistance to local law enforcement and disaster response missions, there are expressed concerns about the program costs, which have been reported to be in excess of \$12,000 per hour.⁷⁰ Although CBP does not pass along the operating costs to local and state governments for the support it provides for law enforcement and disaster response missions, the cost represents a significant taxpayer expense for a mission that can be performed by more traditional aircraft or small UASs, which operate at a fraction of the cost.

The USCG, which is also part of the DHS, is exploring the use of small UASs for ground and cutter-based operations.⁷¹ The use of small UASs by the USCG would represent a significant force-multiplier, increasing maritime awareness by providing potential threat and hazard information during routine

⁶⁸ Ibid.

⁶⁹ Ibid.

⁷⁰ Jack Nicas, "Drone Patrols on U.S. Border Ineffective, Report Finds," *Wall Street Journal*, January 6, 2015, <http://www.wsj.com/articles/inspector-general-criticizes-u-s-border-drone-program-1420576272>.

⁷¹ U.S. Coast Guard, "Unmanned Aircraft System," accessed October 14, 2015, <http://www.uscg.mil/acquisition/uas/>.

enforcement and boarding operations, as well as for environmental surveillance and search and rescue missions. While the USCG and CBP conduct joint operations out of port locations along the Gulf of Mexico,⁷² having access to hand-launched UASs would provide additional UAS options for the USCG that are more cost effective and more rapidly deployed than missions provided by CBP's Predators. This would especially be the case along the coastline of the Atlantic Ocean and for Pacific Ocean operations around Hawaii and the U.S. Territories.

While there has been a delay in the issuance of FAA regulations for government agencies, as of 2013 there were over a dozen local law enforcement agencies, including a total of 81 public entities, seeking FAA approval to operate a UAS in the United States (see Figure 3). The Michigan State Police (MSP) subsequently received FAA approval to operate in February 2015.⁷³ The issuance of a COA to the MSP is noteworthy as it represents the first approval in the nation for the statewide deployment of a UAS for law enforcement operations and emergencies.⁷⁴ The ability to deploy statewide allows for the MSP to assist multiple jurisdictions, unlike the remaining COAs issued to date for law enforcement agencies that have been limited to specific jurisdictional boundaries.

⁷² Ibid.

⁷³ Jennifer Lynch, "FAA Releases New Drone List—Is Your Town on the Map?," Electronic Frontier Foundation, February 7, 2013, <https://www.eff.org/deeplinks/2013/02/faa-releases-new-list-drone-authorizations-your-local-law-enforcement-agency-map>.

⁷⁴ Tom Greenwood, "State Police Gets OK to Use Drones in Investigations," *Detroit News*, March 9, 2015, <http://www.detroitnews.com/story/news/politics/michigan/2015/03/09/michigan-state-police-gets-ok-use-drone/24654161/>.

Figure 3. Map of Domestic Drone Authorizations



Source: "Law Enforcement Agencies Using Drones List, Map," accessed October 15, 2015, <http://www.governing.com/gov-data/safety-justice/drones-state-local-law-enforcement-agencies-license-list.html>.

The first recorded use of a UAS resulting in an arrest by a law enforcement agency in the United States occurred in North Dakota in 2011. At the request of local law enforcement, a U.S. CBP Predator UAS was used to determine the location of several suspects that had earlier brandished weapons in a standoff with local law enforcement. The use of the UAS was controversial as it was deployed without a formal policy in place concerning rules of engagement or privacy protections.⁷⁵ While there were concerns about the lack of a formal policy outlining the use of a CBP UAS for local law enforcement mutual aid assistance, one must not forget or lose sight of the key concern of this mission, which was officer safety. In this case, the use of a CBP UAS facilitated a safe resolution of the incident with no injuries to the law enforcement officers or suspects.

⁷⁵ Kimberly Dvorak, "Homeland Security Increasingly Lending Drones to Local Police," *Washington Times*, December 10, 2012, <http://www.washingtontimes.com/news/2012/dec/10/homeland-security-increasingly-loaning-drones-to-l/>.

The North Dakota incident offers one scenario in which UASs could be used by local, state, and/or federal law enforcement agencies. Other law enforcement situations where UASs could serve a valuable role include crash scene investigations and reconstruction, monitoring traffic flow during traffic jams and evacuations, hostage and barricaded subject situations, search and rescue operations, overhead security for national special security events (e.g., political party convention, presidential and foreign dignitary visits) and large gatherings such as concerts and sporting events. Additionally, UASs would serve as a valuable asset for correctional facilities by providing overhead surveillance for general security missions, such as fence security inspections; reducing contraband smuggling; monitoring large outside inmate gatherings and movements during meal times and recreation periods; as well as for disturbances or other prison emergencies.

C. UNITED STATES AND INTERNATIONAL PROGRAMS COMPARISON

In addition to the United States, two other nations, Australia and Canada, were selected for a review of the use of UASs in their respective countries because they have existing UAS regulations and legislation governing domestic operations. Due to rapidly emerging legislation, rules, and regulations, the review was not a comprehensive legal analysis but rather a review of the general provisions for use that were explored for applicability in the United States.

1. United States

The FAA administers the regulation of UASs in the United States. The primary function of the FAA as outlined in its mission statement is “is to provide the safest, most efficient aerospace system in the world.”⁷⁶ More specifically, the FAA is responsible for the safe and efficient use of the NAS for both civilian and

⁷⁶ Federal Aviation Administration. “About FAA,” accessed August 15, 2015, <https://www.faa.gov/about/>.

military aircraft.⁷⁷ This is somewhat unique in comparison to Canada, which separates the oversight of civilian and military aircraft.

The operation of a UAS in the NAS of the United States by commercial or government entities requires an authorization from the FAA, which must be obtained prior to the commencement of flight operations. This authorization, or COA, can take upwards of 60 business days to obtain.⁷⁸ One-time emergency COAs can be obtained for government agencies but the process of doing so can take upwards of 24 hours to obtain approval and authorization.⁷⁹ For an emergency COA to be issued, the following conditions must apply:

1. A situation exists that is defined as a condition of distress or urgency, where there is, or that has, the extreme possibility of loss of life, and
2. The proponent has determined that manned flight operations cannot be conducted efficiently, and
3. The proposed UAS is operating under a current approved COA for a different purpose or location.⁸⁰

Absent the above mentioned criteria, the request for a COA must follow the normal approval process, which as noted above, can take upwards of 60 business days to obtain approval and authorization to operate.⁸¹ While this may be operationally sufficient for those law enforcement missions that are somewhat static (e.g., long-term surveillance), the current COA process significantly limits the ability of emergency responders to use UASs when responding to dynamic environments experienced during disasters (e.g., flash flooding, tornadoes), not to mention those law enforcement incidents that are more dynamic in nature (e.g., hostage situations).

⁷⁷ Federal Aviation Act of 1958.

⁷⁸ Federal Aviation Administration, *Fact Sheet—Unmanned Aircraft Systems (UAS)*.

⁷⁹ “FAA Approves UAV Deployment for Rescue Group,” Unmanned Aerial Online, September 11, 2014, http://unmanned-aerial.com/e107_plugins/content/content.php?content.546.

⁸⁰ Federal Aviation Administration, *Unmanned Aircraft Systems (UAS) Operational Approval* 2013, <http://www.faa.gov/documentlibrary/media/notice/n%208900.207.pdf>.

⁸¹ Federal Aviation Administration, *Fact Sheet—Unmanned Aircraft Systems (UAS)*.

There are currently two avenues through which to obtain FAA approval for the operation of a UAS in NAS of the United States. The first is “to obtain an experimental airworthiness certificate for private sector (civil) aircraft to do research and development, training and flight demonstrations. The second is to obtain a COA for public aircraft.”⁸² While the issuance of guidance and regulations for public agencies continues to experience delays in release and implementation, §334 of the FAA Modernization and Reform Act of 2012 directs the FAA to “develop and implement operational and certification requirements for the operation of public [UASs] in the [NAS]” by December 31, 2015.⁸³ As with other congressionally mandated deadlines given to the FAA concerning UASs, this deadline was missed. It has been over three years since enactment of the FAA Modernization and Reform Act of 2012, yet minimal progress has been made in implementing operational and certification regulations for the UASs. This continues to hamper the implementation of UASs for both private and public organizations.

In addition, the FAA Modernization and Reform Act of 2012 requires an agreement to be in place with public agencies for the operation of UASs weighing less than 4.4 pounds. The act stipulates UASs must operate via a direct line of sight with the operator, less than 400 feet above ground level (AGL), during daylight hours, within Class G airspace,⁸⁴ and outside of five statute miles from any airport, heliport, seaplane base, spaceport, or other location with aviation activities.⁸⁵ A subsequent agreement in May 2013 between the FAA and the U.S. Department of Justice expanded the maximum allowable weight for law

⁸² Ibid.

⁸³ FAA Modernization and Reform Act of 2012, 49 U.S.C. (2012).

⁸⁴ The FAA notes that Class G airspace “is the portion of the airspace that has not been designated as Class A, B, C, D, or E. It is therefore designated uncontrolled airspace. Class G airspace extends from the surface to the base of the overlying Class E airspace.” Federal Aviation Administration, *The Pilot’s Handbook of Aeronautical Knowledge* (Oklahoma City, OK: Federal Aviation Administration, 2008), 14-9.

⁸⁵ FAA Modernization and Reform Act of 2012, 49 U.S.C.

enforcement COAs from 4.4 to 25 pounds.⁸⁶ The aforementioned stipulations must be met or the operation of a UAS by public agencies is not permissible unless the pilot in command (PIC) and visual observer meet the certification requirements outlined below and the agency in question has an approved COA.

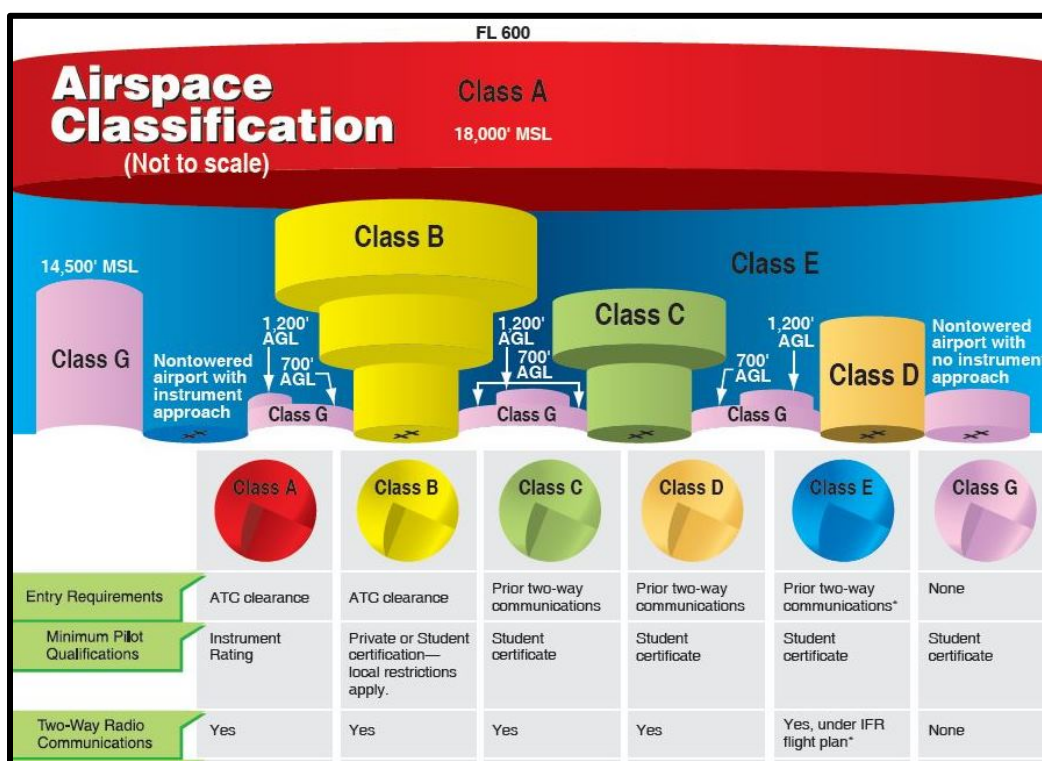
The current certification requirements established by the FAA, which are subject to change, specify a pilot certificate (e.g., airline transport, commercial, private, recreational, or sport pilot certificate) is required for both the PIC and visual observer for UAS flight operations conducted in controlled airspace (e.g., Class A, B, C, D, E) and uncontrolled airspace (e.g., Class G).⁸⁷ Minimum pilot qualifications by airspace classification are listed in Figure 4. While a pilot certificate is currently required for controlled and uncontrolled airspace, a proposed FAA UAS rule, *Operation and Certification of Small Unmanned Aircraft Systems*, would authorize the operation of a UAS in uncontrolled airspace without the requirement to obtain a pilot certificate as long as the PIC and visual observer have successfully completed the FAA Knowledge Test.⁸⁸ Additionally, until such time formal UAS flight training is recommended or required by the FAA, PICs and visual observers should follow the training recommendations outlined by the UAS manufacturer.

⁸⁶ Federal Aviation Administration, *Fact Sheet—Unmanned Aircraft Systems (UAS)*.

⁸⁷ Federal Aviation Administration, "Airworthiness Certification of Unmanned Aircraft Systems and Optionally Piloted Aircraft," accessed February 10, 2016, <http://goo.gl/RVbxTE>; Federal Aviation Administration, "Section 333 Frequently Asked Questions," accessed February 10, 2016, https://www.faa.gov/uas/legislative_programs/section_333/333_faqs/.

⁸⁸ Federal Aviation Administration, "Operation and Certification of Small Unmanned Aircraft Systems," accessed February 10, 2016, <http://www.regulations.gov/#!documentDetail;D=FAA-2015-0150-0017>.

Figure 4. Airspace Classification



Source: Federal Aviation Administration, *Instrument Flying Handbook* (Oklahoma City, OK: Federal Aviation Administration, 2012), 1–3.

When applying for a COA, information must be provided on the proponent, operational description, geographic location, system description, performance characteristics, air worthiness, procedures, avionics equipment, lights, communications, detection/surveillance capability, flight operation plan/maps, flight aircrew qualifications, and any special circumstances.⁸⁹ Failing to provide this information in its entirety will result in a delay or denial of the COA. Additionally, the illegal operation of a UAS, including the failure to obtain a COA, can result in fines ranging from \$1,000 to \$25,000; however, in October 2015 the FAA recommended a record \$1.9 million fine against a company that reportedly

⁸⁹ Federal Aviation Administration, “Certificates of Waiver or Authorization (COA),” accessed August 15, 2015, https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/systemops/aaim/organizations/uas/coal/.

conducted 65 unauthorized flights.⁹⁰ As discussed in the subsequent sections for Australia and Canada, both nations have punitive processes in place similar to the United States for the unauthorized operation of a UAS.

2. Australia

Australia was the first nation to draft laws and legislation pertaining to the use of UASs for civil operations⁹¹ and, as such, offers a tenured policy and guidance structure for the use of UASs, which may be applicable in the United States.⁹² The structure and oversight of those regulations is administered by Australia's Civil Aviation Safety Authority (CASA), whose primary function is to manage the safe regulation of civil air operations in Australia and the operation of Australian aircraft overseas.⁹³ The operation of UASs in the Australian national airspace is broken into the categories of commercial and civil or hobbyist use, and each has a specific set of rules.⁹⁴ For the purposes of this thesis, discussion is limited to the commercial and civil or hobbyist use and not international or overseas operations.

The commercial use of UASs in Australia relates to any type of UAS use that is related to the operations of a private business. The CASA defines the commercial use of a UAS as actions a business may be taking related to its

⁹⁰ Daniel Chaitin, "FAA Warns the Number of 'near Misses' between Drones and Pilots Is Soaring," *Washington Examiner*, August 15, 2015, <http://www.washingtonexaminer.com/faa-warns-the-number-of-near-misses-between-drones-and-pilots-surging/article/2570253>; Bart Jansen, "FAA Seeks Record \$1.9 Million Fine from Drone Company SkyPan," *USA Today*, October 6, 2015, <http://www.usatoday.com/story/news/2015/10/06/faa-drone-fine-skypan-19-million/73441850/>.

⁹¹ RPAS Training and Solutions, "Drone Laws in Australia," Coyne, *UAS Regulatory Developments*. .

⁹² Ibid.

⁹³ Civil Aviation Safety Authority, "About CASA."

⁹⁴ Luke Hopewell, "What Are the Rules about Operating a Drone in Australia?," October 2014, <http://www.gizmodo.com.au/2014/10/what-are-the-rules-about-operating-a-drone-in-australia/>.

operations.⁹⁵ Commercial use of UASs in Australia requires a pilot to obtain an operator's certificate, which validates the pilot's ability to safely operate a UAS as well as pilot awareness of the rules and regulations for operating a UAS in Australia. In addition, approval from the CASA is required before a UAS can be legally operated in Australia.⁹⁶ The flight approval process includes the filing of a flight plan and pilot certifications, with significant penalties for failing to file (e.g., fines, license revocation).⁹⁷ As such, it is critical for pilots to follow standardized procedures much as they would when operating a rotary or fixed-winged aircraft.

The use of a UAS by a government agency for disaster response, as an example, without obtaining CASA approval is at least theoretically possible as long as the platform weighs less than 2 kilograms (kg), remains below 400 AGL, and is not operated over populated areas.⁹⁸ The deployment of a UAS weighing more than 2 kg, operating over 400 feet AGL, or over populated areas requires the issuance of an operating certificate (OC). Additionally, an operator certificate for the individual piloting the UAS is also required.⁹⁹ This is similar to the requirement in the United States for a pilot certification to operate a UAS in controlled and uncontrolled airspace.¹⁰⁰ While there is a comprehensive approval process in Australia to obtain an OC, it is not as stringent as the FAA requirements for UAS operators in the United States.

In Australia, the issuance of an OC can take anywhere from days to months, depending on the complexity of the mission and the backlog in approval

⁹⁵ Civil Aviation Safety Authority Australia, "Civil Aviation Safety Regulations 1998 (CASR), Part 101," 2003, <https://www.casa.gov.au/standard-page/casr-part-101-unmanned-aircraft-and-rocket-operations>.

⁹⁶ Civil Aviation Safety Authority Australia, *Unmanned Aircraft and Rockets* (Advisory Circular 101-1(0)), Civil Aviation Safety Authority Australia, 2002, https://www.casa.gov.au/sites/g/files/net351/f/_assets/main/rules/1998casr/101/101c01.pdf.

⁹⁷ Hopewell, "What Are The Rules About Operating a Drone In Australia?"

⁹⁸ Campbell Simpson. "Australia's Drone Flying Rules Relaxed for Commercial Pilots," June 11, 2015, Gizmodo, <http://www.gizmodo.com.au/2015/06/australias-drone-flying-rules-relaxed-for-commercial-pilots/>.

⁹⁹ Civil Aviation Safety Authority Australia. *Unmanned Aircraft and Rockets*.

¹⁰⁰ Federal Aviation Administration, *The Pilot's Handbook*, 14-9; Federal Aviation Administration, "Section 333 Frequently Asked Questions."

process, with the current timeframe for approval projected at 10 months.¹⁰¹ When submitting a request for an OC, the information that must be listed within the application includes: who may operate the UAS, the geographic operating area, operating altitudes, times/hours of operation, notification requirements, communication requirements, limitations and restrictions, and safety requirements.¹⁰² Failing to list this information will result in a delay or denial of the OC.

When reviewing an OC application, the CASA must ensure the use of a UAS does not pose a greater risk than a comparable mission performed by a manned aircraft, including no significant safety risk to people or property. If deemed necessary, limitations can be imposed on the altitude, geographic area(s), and operational times of the UAS.¹⁰³ Violations of UAS regulations can result in the issuance of fines or penalty units amounting to upwards of \$9,000 (50 penalty units, with one penalty unit equaling \$180 as of July 2015).¹⁰⁴ Though it issues OCs, the CASA also has the authority to assess the fines, which are applicable to any pilot operating a UAS in Australian airspace.

While Australia has a tenured experience with UAS policy and regulations, there are significant hurdles that impact the ability of government agencies to operate UASs in Australian air space. For example, the CASA requires governmental agencies to follow the same processes, regulations, and policies as commercial organizations. This process currently results in, as previously referenced, an approximate 10-month wait to receive an OC approval, which makes an emergency approval process for the use of UASs not practical unless operating a UAS under limiting conditions (e.g., less than 400 feet AGL, small size UASs).

¹⁰¹ Per an August 17, 2015, e-mail received by the author from the Australian CASA, the current projected timeframe for receiving an OC is 10 months and is expected to improve to two months or less in 2016.

¹⁰² Ibid.

¹⁰³ Ibid.

¹⁰⁴ Civil Aviation Safety Authority Australia, "Civil Aviation Safety Regulations 1998."

3. Canada

The regulation of UASs in Canada is administered by Transport Canada for civilian use and by the Canadian Department of National Defence for military applications, which is different from the U.S. policy of integrating the management of civil, commercial, and military aircraft under the FAA as part of an integrated NAS.¹⁰⁵ For the purposes of this thesis, the focus is on Canadian civilian applications, as it more directly relates to domestic disaster response operations.

Transport Canada has the authority and responsibility of establishing and managing the safety and security standards for the operation of civilian aircraft, including UASs, in their airspace. This authority and responsibility includes not only private sector use but law enforcement and disaster response applications as well.¹⁰⁶ This is an area of consistency for the Australia, Canada, and the United States as the CASA, Transport Canada, and FAA retain this authority and responsibility in their respective nations.

For the operation of a UAS to be authorized, a Special Flight Operations Certificate (SFOC) must be issued by Transport Canada. The regulations used by Transport Canada to administer flight safety and security of civilian aircraft, both manned and unmanned, is found in the Canadian Aviation Regulations (CARs).¹⁰⁷ Specific direction is provided in §602.41 of the CARs, which states, “no person shall operate an unmanned air vehicle in flight except in accordance with a[n] [SFOC], or an air operator certificate.”¹⁰⁸ According to the Office of the Privacy Commissioner of Canada, “Currently in Canada there are no established standards...for pilot licensing, certification, maintenance, or command and control of UAVs [UASs].”¹⁰⁹ This is a significant difference from the United

¹⁰⁵ Office of the Privacy Commissioner of Canada, “Drones in Canada.”

¹⁰⁶ Ibid.

¹⁰⁷ Ibid.

¹⁰⁸ Canadian Aviation Regulations, SOR-96-433, §602.41 (2015).

¹⁰⁹ Office of the Privacy Commissioner of Canada, “Drones in Canada.”

States, which, as previously mentioned, requires an airline transport, commercial, private, recreational or sport pilot certificate to operate a UAS in the NAS.¹¹⁰

When Transport Canada issues an SFOC, the authorization, as the name implies, is for special cases and limited to a geographic area for a specific mission. The Regional Transport Canada General Aviation Office must receive requests for an SFOC at least 20 business days prior to the date of intended flight. Once issued, the SFOC can be used for essentially any civil application, including surveillance and disaster response. Information that must be listed within the application includes:

The name, address, and where applicable, the telephone number and facsimile number of the applicant [and operations manager]; the type and purpose of the operation; the date and time of the operation; type and purpose of the operation; description of the aircraft; security plans and emergency contingency plans; and a detailed plan describing how the operation will be carried out including: altitude and routes where the operation will be carried out; the location of any obstacles; and the exact boundaries of the area” where the operation will be conducted.¹¹¹

Failing to list this information on an SFOC application will, as with an OC application in Australia, result in a delay or denial of the application.

Though issued on a case-by-case basis, SFOCs can be approved for long-term use under a blanket authority to operate. Blanket authorities for a defined area can be issued for a specific timeframe if the mission and location of the flight remain unchanged.¹¹² While these parameters are operationally sufficient for law enforcement missions that are somewhat static (e.g., surveillance), they limit the ability of emergency managers to respond to the dynamic environments experienced during disasters (e.g., flash flooding, tornadoes).

¹¹⁰ Federal Aviation Administration, *The Pilot's Handbook*, 14-9; Federal Aviation Administration, “Section 333 Frequently Asked Questions.”

¹¹¹ Canadian Aviation Regulations (2015-1) §623.65 (2003).

¹¹² Office of the Privacy Commissioner of Canada, “Drones in Canada.”

While Transport Canada has essentially excluded model aircraft from regulation, the CARs make a clear distinction between model aircraft and UASs. That clear distinction is that model aircraft must be used for recreational purposes only and weigh less than 35 kg. If a model aircraft is used for non-recreational purposes (e.g., disaster response) and/or exceed 35 kg, it is considered a UAS and can only operate under an SFOC unless its use is consistent with a November 2014 exemption issued by Transport Canada permitting the operation of small UASs without an SFOC.¹¹³ Failing to obtain an SFOC can result in a fine of \$5,000 for individuals and \$25,000 for corporations/organizations.¹¹⁴ While these penalties are substantial, Canada is more lenient overall in comparison to both Australia and the United States concerning current operational limitations on UASs.

As noted previously, there is some leniency in Canada for the operation of UASs as “there are no established standards for pilot licensing, certification, maintenance, or command and control.”¹¹⁵ Additionally, the aforementioned November 2014 exemption permits the operations of a UAS without an SFOC as long as the UAS weighs less than 2 kg and the operator complies with the listed exemption criteria (e.g., operations must be at or below 300 feet AGL). The operation of a UAS with a weight between 2.1 kg and 25 kg is permissible without an SFOC as long as Transport Canada is notified.¹¹⁶ These exemptions are significant and indicate a progressive UAS environment for both the government and private sector use of UASs in Canada and are worthy of consideration for application in the United States.

¹¹³ Canadian Aviation Regulations (SOR-96-433) § 101.01 (2015); Civil Aviation Government of Canada, Transport Canada, and Safety and Security Group, “Flying an Unmanned Aircraft for Work or Research,” May 21, 2015, <http://www.tc.gc.ca/eng/civilaviation/standards/standards-4179.html>.

¹¹⁴ Civil Aviation Government of Canada, Transport Canada, and Safety and Security Group, “Advisory Circular (AC) 600-004,” November 26, 2014, <https://www.tc.gc.ca/eng/civilaviation/opssvs/ac-600-004-2136.html>.

¹¹⁵ Office of the Privacy Commissioner of Canada, “Drones in Canada.”

¹¹⁶ Civil Aviation Government of Canada, Transport Canada, and Safety and Security Group, “Flying an Unmanned Aircraft for Work or Research.”

D. COMPARATIVE PROGRAMS ANALYSIS

Based on a comparison of the UAS programs currently in place for the United States, Australia, and Canada, as well as a review of military, homeland security and law enforcement programs, there is significant room for improvement in the United States if UASs are going to be deployed to any significant degree. While the United States is, as noted, recognized as a world leader in UAS technology, the U.S. policy for civilian and public agency use is so restrictive that the domestic use of UAS is significantly limited.

Limitations in place for both the United States and Australia hinder the use of UAS by governmental organizations as the approval process for their operation is the same, or similar, to the processes in place for commercial use. By applying the same or similar process to governmental agency approvals as they do commercial or civilian approvals, the existing FAA procedures force governmental agencies, in many cases, to either skirt the official approval process by using other platform options, such as tethered UASs; operate a UAS without authorization; rely on volunteer hobbyists to provide UAS coverage; continue to use more expensive resources, such as rotary and/or fixed-winged aircraft; or obtain federal UAS support via the FEMA mission assignment process (i.e., DSCA support) for those incidents warranting federal government resources.

While it is recognized that a pre-deployment training program or certification for government agency UAS operators is necessary for liability purposes and to build operational skills, that training or certification should not present a significant burden to the agencies that are implementing a UAS program. However, the stipulation for government agency UAS operators to possess an airline transport, commercial, private, recreational, or sport pilot certificate does exactly that as it creates costly and labor intensive requirements that are prohibitive for many organizations. This is especially the case for many local law enforcement, fire, and, more specifically for the purposes of this thesis, emergency management agencies. Aside from the additional costs to complete

the training necessary to obtain an airline transport, commercial, private, recreational, or sport pilot certificate, the costs to hire and maintain qualified UAS pilots creates a burden that should be re-evaluated, especially for small UASs.

As noted previously, Canada does not require a license or an SFOC for small UASs in the 2.2 kg to 25 kg range. While it is recognized that a requisite level of training should be required for operational and liability purposes, it would be prudent for the United States to implement a similar provision in the United States for government agencies, even if such a provision was limited to UASs weighing five pounds or less. In doing so, it would allow local and state emergency management agencies to rapidly deploy a small UAS to, among other missions, determine the impact of a disaster, obtain SA as part of the development of a COP, locate survivors of disasters, and conduct search and rescue operations.

IV. POTENTIAL USES OF UASS FOR EMERGENCY AND DISASTER RESPONSE MISSIONS

If everybody is thinking alike, then somebody isn't thinking.

— General George S. Patton, Jr., U.S. Army

Before developing policies, procedures, and a programmatic structure for an emergency management UAS program, it is necessary to have an understanding of the potential uses of UASs for disaster response missions. Agencies and organizations should not develop a UAS program merely for the sake of doing so. Finn and Wright explain, “UASs have a niche in performing the three D’s: dull, dirty, and dangerous work.”¹¹⁷ Additionally, Brecher offers that UASs “can be deployed on demand...have flexibility in tasking...have plug and play capabilities for their payloads...can support high—resolution cameras...[and] can cover remote areas.”¹¹⁸ Having an understanding of the potential uses offered by UASs would assist in objectively identifying areas where UASs can augment current capabilities.

This author posits that UASs may be particularly well-suited for local and regional emergency management programs and can enhance the state-level support to local government agencies during disasters. For example, recognizing the need to deploy resources as quickly as possible in the aftermath of a disaster, initiatives, such as the state of Ohio’s 4/72 Project, are intended to rapidly deploy resources as part of a coordinated response to disasters. The intent of Ohio’s 4/72 Project is to provide essential resources within four hours of an incident and reflects a shift in the emergency management paradigm that will enhance the state’s ability to respond to disasters quicker and more efficiently

¹¹⁷ Rachel L. Finn, and David Wright, “Unmanned Aircraft Systems: Surveillance, Ethics, and Privacy in Civil Operations,” *Computer Law & Security Review* 28, no. 2 (2012): 185.

¹¹⁸ Aviva Brecher, “Roadmap to Near-Term Deployment of Unmanned Aerial Vehicles (UAVs) for Transportation Applications Charge to Participants” (lecture, UAV 2003: Roadmap for Deploying UAVs in Transportation Specialist Workshop, Santa Barbara, CA, December 2, 2003).

than at any time in Ohio history. The program is sustainable for 72 hours and focuses on providing critical needs, such as water, food, baby formula, blankets, and generators to help emergency managers assist their communities during disasters.¹¹⁹ The 4/72 Project represents an opportunity for UASs to assist in determining the preliminary impact of the disaster, as an indicator of increased need, and the status of roadways for transporting critical needs items.

An advantage offered by UASs in comparison to rotary and fixed-winged aircraft is their ability to obtain unique observation angles that are not practical or otherwise possible via conventional means. As shown in Table 1, UASs can or have been used for conducting agricultural inspections, assessing critical infrastructure (e.g., bridges, oil and gas pipelines, power transmission lines), conducting confined space inspections, detecting wildfires, determining building and structural integrity, determining COP and SA, conducting environmental monitoring and sampling (e.g., chemical, biological, radiological), developing geo-mapping products (e.g., overhead maps), conducting aerial reconnaissance, conducting search and rescue operations, conducting structural firefighting operations (e.g., determining location of victims, deploying fire retardant via larger UASs), and transporting medical supplies and equipment (e.g., pharmaceuticals, AEDs).

Table 1. Potential Emergency Management Related UAS Missions

Agricultural Inspections	Determine COP/SA
Assessing Critical Infrastructure	Environmental Monitoring/Sampling
Confined Space Inspections	Geo-Mapping
Damage Assessments	Reconnaissance
Detecting Wildfires	Search and Rescue Operations
Determine Building/Structural Integrity	Transporting Medical Supplies

¹¹⁹ Ohio Department of Public Safety, *Ohio Department of Public Safety 2015 Annual Report* (Columbus, OH: Ohio Department of Public Safety, 2015), 2, 21.

Collapsed buildings pose an especially hazardous situation for responders due to the instability of the structure. UASs provide an alternative to sending responders into an unstable building environment, and they can ascertain the status of a structure with the added benefit of being able to provide real-time audio/video and environmental air sampling. Not only does there appear to be an emerging interest in using small UASs for structural assessments, but, as noted by Duncan, and Murphy, experiments have indicated that small UASs have been able to enter the hot zone of a contaminated area and begin transmitting usable data within 16 minutes. This timeframe is significantly faster than what can be accomplished by a traditional hazardous materials (HazMat) or radiation monitoring team.¹²⁰ The data gathered during these experiments is a critical observation as not only was the UAS able to perform the assessments without placing responders in a hazardous situation, it was able to provide critical environmental information to incident command staff more expeditiously. This is yet another example of how UASs can augment incident response when operations are not limited by bureaucratic restrictions, such as the aforementioned requirement to obtain a COA from the FAA prior to mission deployment for disaster and life safety missions.

Critical infrastructure inspections (e.g., bridges, oil and gas pipelines, power transmission lines) are often conducted via an aerial assessment by conventional fixed and rotary-winged aircraft or by physical inspection. Bridge inspections, for instance, are expensive, time-consuming, and dangerous. With the exception of non-redundant bridge trusses, for which the Federal Highway Administration requires a hands-on inspection, using UASs for bridge inspections would compress the time it takes to complete inspections, reduce lane closures, reduce costs, and more importantly, would be safer.¹²¹ While the capability to

¹²⁰ Duncan, and Murphy, "Autonomous Capabilities for Small Unmanned."

¹²¹ Federal Highway Administration, "Revisions to the National Bridge Inspection Standards (NBIS)," Technical Advisory, Federal Highway Administration, accessed November 11, 2015, <http://www.fhwa.dot.gov/bridge/nbis/t514021.cfm>; Brady Slater, "MnDOT Testing Drones for Bridge Inspections," *TwinCities*, November 3, 2015, http://www.twincities.com/localnews/ci_29073232/mndot-testing-drones-bridge-inspections.

perform transportation infrastructure inspections represents a significant benefit in day-to-day operations, it is critical for disaster response missions. This is especially the case in the aftermath of an explosion, flood, hurricane, or earthquake, due to the immediate need to re-open highways for ingress and egress into the areas impacted by the incident.

Oil and gas incidents pose a unique challenge for field monitoring teams due to the volatility of the products extracted from the wells. Currently, oil and gas companies use either handheld detectors or helicopters to detect methane leaks. Aside from the cost of these systems, they require the operator or pilot to operate dangerously close to the well pad to obtain readings or confirmation of a methane or other volatile chemical release.¹²² With over 500,000 hydraulically fractured gas wells in the United States, UASs present a potential industry-wide method that would be provide a less expensive and safer option for conducting air monitoring than what is currently available via conventional means.¹²³ From an emergency response perspective, UASs would serve as a valuable resource during well pad incidents due to their rapid deployability; however, their use would require an exemption for operation in incidents where a no fly zone has been established.

Wildland fires present challenges for firefighters in not only fire suppression but also in the development of SA/COP for the incident. Similar to other incidents, such as floods, earthquakes, tornadoes, landslides, and building collapses, UASs can provide valuable awareness than can aid response efforts by identifying areas where suppression efforts need to be expanded. Moreover, the future may very well bode the introduction of UASs deploying fire retardant. However, a more important role for UASs may arguably be in the detection of wildland fires before they significantly expand.

¹²² Reid Frazier, "Could Drones Detect Leaks at Oil and Gas Sites?," *Michigan Radio*, March 12, 2015, <http://michiganradio.org/post/could-drones-detect-leaks-oil-and-gas-sites>.

¹²³ Mark Crawford, "Methane-Sniffing Drones in Fracturing Operations," ASME, February 2015, <https://www.asme.org/engineering-topics/articles/energy/methanesniffing-drones-in-fracturing-operations>.

A team of researchers is currently working on a project called Fire Urgency Estimator in Geosynchronous Orbit (FUEGO), which would serve as an early detection system for wildland fires.¹²⁴ The ongoing drought in the western United States has extended the wildland fire season and, as such, reinforces the need for an early detection system such as FUEGO. The early warning system comprising FUEGO

would consist of infrared cameras mounted on drones and piloted aircraft...plus another camera on a satellite. The cameras would snap photos...[and] a computer would then subtract recent photos from new ones of the same area, and by looking at the difference be able to tell when a new fire has erupted.¹²⁵

While FUEGO is still its infancy, it is an example of how a UAS-based sensor system may be deployed in the future to provide for the rapid, pinpoint detection of wildland fires. Such pinpoint accuracy would result in firefighters being able to respond more expeditiously to wildland fires that may otherwise go undetected for a significant amount of time.

The use of UASs also represents a force multiplier for those fire departments that deploy an air reconnaissance chief (ARC) during fire response operations. As an example, the current policy of the Fire Department City of New York (FDNY) is to have a battalion chief, operating as the ARC, deploy automatically for high-rise business and residential fires, as well as for building collapses.¹²⁶ The activation of an ARC can also occur for multiple alarm fires, weapons of mass destruction incidents, special events, and for incidents spanning large geographic areas that are otherwise inaccessible.¹²⁷ The role of the ARC is to provide an overhead scene assessment (e.g., imminent hazards, structural integrity, location(s) of building occupants) to the incident commander

¹²⁴ Shelby Carpenter, "Fighting Forest Fires before They Get Big—With Drones," *WIRED*, June 9, 2015, <http://www.wired.com/2015/06/fighting-forest-fires-get-big-drones/>.

¹²⁵ *Ibid.*

¹²⁶ Fire Department City of New York, *Air Support Plan* (A.U.C. 269) (New York: Fire Department City of New York, 2005), 2.

¹²⁷ *Ibid.*

(IC) on the ground.¹²⁸ This assessment is critically important to the IC as it will assist with guiding the priorities, objectives, strategy, and tactics comprising the incident action plan.

Since FDNY does not have a helicopter in its inventory, the New York Police Department (NYPD) provides air support for FDNY on an as requested and available basis. While NYPD is uniquely equipped to provide the support necessary, it is not always timely due to travel time and conflicting missions, which in turn wastes valuable response time.¹²⁹ Additionally, when deployed for aerial support, a battalion chief, who would otherwise be available to respond to another incident, or fill a command and general staff position within the ICP, is not available. To address this issue, whether within the FDNY or other fire departments, the deployment of a UAS would decrease the time necessary to obtain an on-scene assessment or SA, thereby expediting the sharing of incident information (e.g., live video feed, telemetry) with the ICP and EOC.

Whether updating flood maps or geo-mapping an area before and after a disaster, the reconnaissance and mapping capabilities afforded by UASs offer emergency managers and first responders a valuable resource that can assist with not only day-to-day operations but disaster response and emergency operations as well. UASs offer a rapidly deployable resource that can provide live video feeds to ICPs and EOCs. While having this level of access to a disaster scene provides a level of granularity not traditionally available to many incident commanders, a study by McGuirl, Sarter, and Wood reveals that having access to live imaging data can cause data from other sources (e.g., field reports, dispatch information) to be overlooked. Such an oversight can negatively impact operations by not completely factoring all data sources into command staff

¹²⁸ Ibid.

¹²⁹ Jim Hoffer, "Concerns over Lack of FDNY Helicopter," *ABC7 New York*, February 4, 2009, <http://abc7ny.com/archive/5789307/>.

decision-making processes.¹³⁰ While the results of the study could be an anomaly, the key takeaway is the criticality for command staff to not develop tunnel vision by focusing on a single data source. Nonetheless, ICPs and EOCs should take advantage of all available data sources to assist in obtaining SA/COP as they develop response strategies for responding to a given disaster or emergency situation.

Search and rescue operations are particularly well-suited for small UASs as operations often occur in densely populated areas or confined space environments. As a case in point, in July 2014, an amateur UAS operator was able to locate an elderly missing adult in a heavily wooded area in Virginia. The man had been missing for three days and previous searches involving first responders, search canines, a helicopter, and hundreds of volunteers on foot had failed to locate him. Not only was the UAS operator able to locate the missing man, the operator was able to locate him within approximately 20 minutes of deployment.¹³¹ A significant point to note in this instance is the reliance on the general public to provide a UAS to search for the missing man due to FAA restrictions, which limit the use of UASs by governmental agencies and commercial organizations.

Other search and rescue missions that can be performed by UASs include searching for survivors from flash floods and mountain rescues. Two recent incidents in Texas saw the use of a UAS assist first responders during flash flood rescue missions. In the first incident, a volunteer UAS operator, using a search light payload, guided responders to the location of a truck that had been swept away by flash flooding. In the second incident, the same UAS operator was able to transport a rescue rope to people stranded in a mobile home that was

¹³⁰ John McGuirl, Nadine Sarter, and David Woods, "Incident Command Situation Assessment Utilizing Video Feeds from UAVs: New Risks for Decision Making Breakdowns." In *Crisis Management: Concepts, Methodologies, Tools, and Applications* (858–874) (Hershey, PA: IGI Global 2014), doi:10.4018/978-1-4666-4707-7.ch042.

¹³¹ Edie Sellers, "Amateur Drone Pilot Finds Man Missing for Three Days...in 20 Minutes," *Examiner*, July 22, 2014, <http://www.examiner.com/article/amateur-drone-pilot-finds-man-missing-for-three-days>.

otherwise inaccessible by boat. Subsequently, the residents were provided with life preservers and rescued via helicopter lift.¹³² In both instances, a UAS assisted responders in rescuing flood victims that may have perished otherwise.

While one could assert that an emergency COA could have been obtained for the emergency situations noted above, the fact remains a civilian hobbyist was able to provide a service that could not be readily obtained by government or commercial agencies. This case serves as one of several instances where a civilian hobbyist has been able to render assistance by employing UASs, while government agencies remain handcuffed by overly restrictive bureaucratic FAA rules and regulations. The interpretation espoused by the FAA, that a UAS operated by a civilian hobbyist is not an aircraft but one operated by a government agency is, represents a clear contradiction in logic that must be addressed if UASs are going to be used to their full potential. Chapter V reviews and analyzes other barriers that pose challenges for agencies looking to establish a UAS program.

¹³² Kelsey Atherton, "Watch a Drone Save Texans from a Flash Flood," *Popular Science*, May 19, 2015, <http://www.popsci.com/watch-drone-save-texans-flood>.

V. BARRIERS IMPACTING FORMAL INTEGRATION OF UASS INTO DISASTER RESPONSE

If you don't know what your barriers are, it's impossible to figure out how to tear them down.

— John Manning, author

There are many barriers that may limit the ability of agencies and jurisdictions to implement a UAS program for domestic use. Examples of these barriers include: concerns about privacy and Fourth Amendment protections afforded under the U.S. Constitution; connotations that UASs are primarily military, law enforcement, or homeland security platforms; limitations on use posed by FAA rules and regulations; and potential ethical concerns pertaining to UAS manufacturers due to an association of their brand name with military or surveillance applications.

Data from the aforementioned 2013 Monmouth University poll suggests there is significant concern among the general public in the United States regarding privacy protections from government intrusion.¹³³ For example, information from the poll concerning the domestic operation of UASs in the United States discovered that 80 percent of the respondents voiced privacy concerns for law enforcement missions using high resolution cameras.¹³⁴ This data indicates a significant challenge for both law enforcement and emergency management agencies as the general public cannot necessarily determine whether a mission is surveillance or disaster response related. Unless the intent of the mission is clearly delineated, segments of the general public may assume the UAS is conducting a surveillance mission, which many may consider an invasion of privacy.

¹³³ Monmouth University, "National: U.S. Support Unarmed Drones."

¹³⁴ Bart Jansen, "Americans Oppose Using Drones to Catch Speeders, Poll Finds," *USA Today*, June 12, 2012, <http://www.usatoday.com/news/nation/story/2012-06-12/poll-drone-use-speeders/55554424/1>; Monmouth University, *National: U.S. Support Unarmed Drones*.

Opponents to the use of UASs by government agencies argue that privacy protections afforded under the Fourth Amendment of the U.S. Constitution limit the use of UASs and thereby their use by the government constitutes a civil rights violation; however, neither the Fourth Amendment nor the U.S. Constitution directly address the right to privacy.¹³⁵ Additionally, as stated by Ison, Terwilliger, and Vincenzi, “The range of [U.S.] Supreme Court and lower court decisions that set the precedent for privacy assurances have dictated that short-term aerial surveillance does not constitute a search in terms of the Constitution.”¹³⁶ This is a noteworthy observation considering privacy concerns are not only reflected in poll numbers¹³⁷ but in incidents, such as the previously noted landslide in Oso, WA, in which a UAS mission was reportedly canceled due to potential privacy concerns regarding photos or video that would be taken during mission deployments.¹³⁸ As such, it is critical for agencies and jurisdictions to proactively market their UAS programs for their humanitarian benefits and ensure provisions are in place to address privacy concerns.

Interestingly enough, similar concerns and limitations are typically not points of contention when missions are conducted via conventional platforms, such as fixed and rotary-winged aircraft. This begs the question of why is there a perceived difference between the use of conventional aircraft and UASs. While some argue that the use of UASs domestically poses no more of an invasion of privacy or ethical concern than those posed by conventional rotary or fixed-winged aircraft, these aircraft, as opposed to a UAS, allow a person, due to the noise exhibited by the aircraft, “to take measures to keep private those activities

¹³⁵ U.S. Const. Amend. IV; Judicial Learning Center, “Your 4th Amendment Rights,” accessed January 6, 2016, <http://judiciallearningcenter.org/your-4th-amendment-rights/>.

¹³⁶ David C. Ison, Brent Terwilliger, and Dennis Vincenzi, “Privacy, Restriction, and Regulation Involving Federal, State and Local Legislation: More Hurdles for Unmanned Aerial Systems (UAS) Integration?,” *Journal of Aviation/Aerospace Education & Research* 24, no. 1 (2014): 50, <http://commons.erau.edu/jaaer/vol24/iss1/3/>.

¹³⁷ Monmouth University, *National: U.S. Support Unarmed Drones*.

¹³⁸ Murphy, “Oso, Washington Mudslides: We Had the UAVs.”

that they do not wish to expose to public view.”¹³⁹ An additional concern expressed by Finn and Wright is a term they refer to as “function creep,” whereby a UAS that is intended for a specific purpose (e.g., disaster response) expands to include an additional function (e.g., monitoring an area for criminal indicators).¹⁴⁰ Finn and Wright further advocate that the insufficiency of current legislation governing the domestic use of UASs has a disparate effect on marginalized populations.¹⁴¹ Potential ethical areas such as this, as well as the aforementioned concerns that may be found among marginalized populations, do pose challenges, actual or perceived, and will continue to impact the use of UASs domestically. As such, these concerns should be considered as part of any program policy.

Nonetheless, absent varying state legislation, the aforementioned February 2015 presidential memorandum issued by President Obama and limited or outdated rules and regulations from the FAA, indicate that privacy is an area that needs to be addressed as there is no central national standard for UAS privacy controls. This observation is also advanced by Ison, Terwilliger, and Vincenzi who posit, “The lack of initiative to impose specific privacy restrictions or controls over UAS operations by the FAA opens the door to federal, state, and local entities imposing their own rules and regulations.”¹⁴² However, applying a double-standard to UASs in comparison to ground-based and other conventional aerial reconnaissance platforms is counterproductive. While privacy concerns must be considered and respected, they should not limit the use of UASs for disaster response missions due to the potential lifesaving aspects of those mission deployments.

¹³⁹ Paul McBride, “Beyond Orwell: The Application of Unmanned Aircraft Systems in Domestic Surveillance Operations,” *Journal of Air Law and Commerce*, 74, no. 3 (2009): 628; Rachel L. Finn, and David Wright, *Study on Privacy, Data Protection and Ethical Risks in Civil Remotely Piloted Aircraft Systems Operations* (Luxembourg: Publications Office of the European Union, 2014), 7.

¹⁴⁰ *Ibid.*, 7.

¹⁴¹ Finn, and Wright, “Unmanned Aircraft Systems: Surveillance,” 185.

¹⁴² Ison, Terwilliger, and Vincenzi, “Privacy, Restriction, and Regulation,” 2.

Another barrier presenting challenges for the domestic use of UASs is the connotation fostered by some segments of the population who assert the use of UASs is primarily militaristic, law enforcement or homeland security centric and represents a threat to the United States. While the validity of this connotation can be debated, the associated perceptions and concerns inhibit the widespread use of UASs by government agencies for humanitarian missions such as disaster response. Whether public opinion is responsible for the delay in the issuance of FAA rules and regulations is not possible to determine. However, such an impact would not be unheralded and is noted by the Aerospace Industries Association (AIA), which suggests,

As with any emerging technology, public opinion regarding these systems often begins in the imagination, and may harden into myth through misconception, popular culture and an inability to imagine the non-military benefits of a platform that has traditionally been used for national defense.¹⁴³

While some may believe it is relatively easy to debunk these myths and perceptions or to disavow them as an evanescent opinion, the reality is not that simple.

With recent reports of UASs disrupting wildfire response operations,¹⁴⁴ encroaching on air space near airports,¹⁴⁵ breaching the fence line at the White House,¹⁴⁶ and publicized concerns about the use of UASs for acts of

¹⁴³ Aerospace Industries Association, *Unmanned Aircraft Systems: Perceptions and Potential* (Arlington, VA: Aerospace Industries Association, 2013), http://www.aia-aerospace.org/assets/AIA_UAS_Report_small.pdf, 3.

¹⁴⁴ Jim Steinberg, and Joe Nelson, "Drone over Massive San Bernardino County Fire 'Could've Killed Everybody in the Air,' Official Says," *San Bernardino Sun*, June 25, 2015, <http://www.sbsun.com/general-news/20150625/drone-over-massive-san-bernardino-county-fire-couldve-killed-everybody-in-the-air-official-says>.

¹⁴⁵ Ken Kaye, "JetBlue Pilot: Drone in Flight Path at Fort Lauderdale Airport," *Sun-Sentinel*, September 15, 2015, <http://www.sun-sentinel.com/local/broward/fl-jetblue-vs-drone-20150914-story.html>.

¹⁴⁶ Michael S. Schmidt, "Small Drone Breaches White House Grounds, Prompting Lockdown and New Security Worries," *Boston Globe*, January 27, 2015, <https://www.bostonglobe.com/news/nation/2015/01/27/small-drone-breaches-white-house-grounds-prompting-lockdown-and-new-security-worries/099pWS05bMjfZAM02fA2dM/story.html>.

terrorism,¹⁴⁷ segments of the population in the United States, and other nations for that matter, exude varying levels of apprehension concerning the domestic use of UASs. To assist in mitigating many of the myths and connotations surrounding the use of UASs for domestic missions, agencies should consider a public awareness and education program outlining the benefits of their use. This awareness and education program should not be a short-term initiative but rather a structured, formal component to any governmental agency UAS program.

While giving due consideration to privacy concerns and public perceptions, limitations on UAS use posed by FAA rules and regulations are arguably the greatest hurdle currently limiting their domestic use in the United States. As noted previously, while processes for emergency requests exist, the 60-day timeframe to obtain a non-emergency COA for government agencies desiring to deploy UASs for disaster response missions represents an extremely high level of bureaucracy. Congress and the FAA have been shortsighted in their approach to establishing UASs rules and regulations as the FAA Modernization and Reform Act of 2012 places, or at least appears to place, a higher emphasis on approving civilian operations than public or governmental agency use.¹⁴⁸ The argument can be made that the development of government agency rules and regulations should have been given the highest priority. However, the fact remains that the FAA has repeatedly missed congressionally mandated deadlines outlined in the act, including the recent September 30, 2015 deadline to develop civil use rules and regulations.¹⁴⁹ As expected with missing congressionally mandated deadlines, there has been an increasingly vocal outcry from Congress, as well as public and private sector organizations, to finalize the UAS rules and regulations.

¹⁴⁷ Jeff Pegues, "Homeland Security Warns Drones Could Be Used in Attacks," CBS News, July 31, 2015, <http://www.cbsnews.com/news/homeland-security-warns-drones-could-be-used-in-attacks/>.

¹⁴⁸ FAA Modernization and Reform Act of 2012, 49 U.S.C.

¹⁴⁹ Mark Rockwell, "FAA Looks to 2016 for Drone Rules," *FCW*, September 30, 2015, <https://fcw.com/articles/2015/09/30/faa-drones.aspx>.

The missed deadlines were not necessarily unexpected, as a 2014 U.S. Department of Transportation Office of Inspector General report noted the FAA would miss the established deadlines due to “significant technological barriers, including detection and standardized air traffic procedures and other issues.”¹⁵⁰ However, in all fairness, a review of UAS platforms operating in 2013 noted there were 270 companies worldwide that were manufacturing no less than 960 distinct types of UASs, including 144 in the United States alone.¹⁵¹ These numbers have assuredly increased since 2013, which presents challenges for air traffic controllers regarding the necessary spectrum allocations necessary for operating UASs in the NAS.¹⁵² While the potential hazards posed by UASs in the NAS is recognized, the fact remains that UASs represent a viable and effective tool that can be used by emergency management organizations during disasters. Therefore, the FAA needs to expedite the approval of the rules and regulations governing their use by governmental agencies. However, as previously noted, these rules and regulations cannot be so stringent that they stifle the expansion of the domestic use of UASs for disaster response.

Ethical considerations pose a potential barrier concerning the domestic use of UASs in the United States. Disasters do not discriminate based on nationality, race, gender, or socio-economic status, yet they often impact populations that may consider their in-group to be marginalized within a given society. As a result, the use of UASs, regardless of whether disaster response related or not, may present a perceived risk of discrimination due to apprehension about the intent of the UAS mission due to its governmental nexus. This may especially be the case concerning the capturing and retention of aerial photos or video. Therefore, as noted by Finn and Wright, “it is essential for [UAS]

¹⁵⁰ U.S. Department of Transportation, Office of Inspector General, *FAA Faces Significant Barriers to Safely Integrate Unmanned Aircraft Systems into the National Airspace System* (Washington, DC: U.S. Department of Transportation Office of Inspector General, 2014).

¹⁵¹ J. R. Wilson, “UAV Roundup 2013,” *Aerospace America* 51, no. 7 (2013): 26, <http://goo.gl/rgLwzN>.

¹⁵² Aerospace Industries Association, *Unmanned Aircraft Systems*.

operators to enact information sharing practices to provide members of the public with knowledge about the specific activities being undertaken.”¹⁵³ A failure to do so only serves to perpetuate misinformation that may permeate the public perception concerning the domestic use of UASs.

As noted previously, Gilman offers an interesting ethical concern by commenting, “The military remains the largest user of UAVs [UASs], while the manufacturers are primarily military contractors. This situation raises ethical and operational considerations for humanitarian organizations, who may not wish to be associated even indirectly with military actors.”¹⁵⁴ Steen Mogensen, chief executive officer of Scion UAS, recognizes a potential issue with UASs and their association with military applications, as he notes the term *drone* “strikes fear into a lot of people.”¹⁵⁵ Conversely, Nelson Paez, who is the CEO of DreamHammer, a UAS software development company, dismisses potential ethical concerns for companies such as his, by noting they are no more responsible for the use of their product than Microsoft is for the use of their various products.¹⁵⁶ Paez’s statement is consistent with existing research data, which does not indicate support of the opinion posited by Gilman. However, it should be noted that for the purposes of this thesis, research on this topic was primarily limited to the United States and does not address potential ethical concerns in nations that have seen significant military UAS operations (e.g., Afghanistan, Pakistan).

Another barrier to implementing a domestic UAS program, whether for emergency management or other domestic missions (e.g., law enforcement), is the haste in which some governmental agencies have rushed to implement a UAS program. Hastily implementing a UAS program without having vetted plans and procedures in place, as well as sufficient funding, and failing to obtain public

¹⁵³ Finn, and Wright, *Study on Privacy*, 36.

¹⁵⁴ Gilpin, *Unmanned Aerial Vehicles in Humanitarian Response*.

¹⁵⁵ Ben Terris, “Can Drones Be Known for More Than Causing Death?” *National Journal*, August 13, 2013, <http://www.nationaljournal.com/s/72190/can-drones-be-known-more-than-causing-death>.

¹⁵⁶ *Ibid.*

support from the affected citizenry are areas that will quickly derail a program before it is implemented.

Two examples of hastily implemented UAS programs, which were subsequently canceled after the procurement of UASs, occurred in the state of Washington. The Seattle Police Department (PD) previously purchased two UASs; however, the program was reportedly canceled after a public outcry by the general public and a lack of support from city council and the mayor's office.¹⁵⁷ In another instance, the King County, WA, Sheriff's Office returned a UAS it had obtained from Seattle PD due to what the sheriff noted as a failure to do its "homework" before accepting the UAS.¹⁵⁸ A similar example is noted in the state of Texas where the Department of Public Safety canceled its UAS program due to operational issues.¹⁵⁹ After spending \$295,000 on two UASs, it was determined the UASs not only lacked the design to operate in the rocky terrain in many parts of Texas, they did not function well in high winds.¹⁶⁰ These examples highlight the unintended consequences of implementing a UAS program prior to, in the case of Seattle, obtaining public and elected official support, and, in the case of Texas, failing to research system design requirements prior to procurement.

The last barrier explored as part of this thesis is the difficulty in obtaining initial funding to procure a UAS(s) and issues pertaining to UAS program sustainment costs. Funding for UASs is theoretically available under the U.S. DHS Homeland Security Grant Program (HSGP) via the State Homeland Security Program (SHSP), Urban Area Security Initiative (UASI) grants, and the Emergency Management Performance Grant (EMPG), as UASs are on the

¹⁵⁷ Christine Clarridge, "Seattle Grounds Police Drone Program," *The Seattle Times*, February 7, 2013, <http://www.seattletimes.com/seattle-news/seattle-grounds-police-drone-program/>.

¹⁵⁸ Ibid.

¹⁵⁹ Jennifer Lynch, "Texas Cancels Its Drone Program for Maintenance Issues," Electronic Frontier Foundation, January 24, 2012, <https://www.eff.org/deeplinks/2012/01/texas-department-public-safety-cancels-its-drone-program>.

¹⁶⁰ Ibid.

Approved Equipment List (AEL). However, FEMA has recently temporarily halted the funding for UASs pending the implementation of recommendations by the White House Law Enforcement Working Group, established as a result of Executive Order 13688.¹⁶¹ A general notice recognizing the temporary stay in UAS funding authorizations under the aforementioned grant programs is annotated on the AEL.¹⁶² While it is unfortunate that FEMA has taken this position, this was not unexpected due to the delays by the FAA in issuing UAS rules and regulations for governmental organizations. As a result of the temporary suspension in funding authorizations for UASs by FEMA, departments that were in the process of procuring and implementing a UAS program have either been forced to cease the implementation of UAS programs or locate other funding sources.

While the current stay on using EMPG, SHSP, or UASI funds for UAS procurement and/or sustainment presents challenges, some agencies have used alternate funding sources and donations to fund their UAS program. For example, the Medina County, Ohio (OH) Sheriff's Office received two UASs from a local vendor who was interested in obtaining a law enforcement perspective as it developed its product line.¹⁶³ By partnering with a private sector entity, the Medina County Sheriff's Office was able to implement a UAS program that may not have been feasible otherwise due to budgetary restraints.

¹⁶¹ Exec. Order No. 13688, 80 FR 3451 (2015), <https://www.gpo.gov/fdsys/pkg/FR-2015-01-22/pdf/2015-01255.pdf>.

¹⁶² FEMA's AEL notes, "Prior to obligating funds for this category of equipment, grantees must obtain a waiver from FEMA by consulting with their Program Analyst and providing a detailed justification for obligating funds in this category, and receiving approval to obligate funds. Pending FEMA's implementation of the recommendations of the White House Law Enforcement Working Group, which was established as a result of Executive Order 13688: "Federal Support for Local Law Enforcement Equipment Acquisition," GPD will not approve requests for 03OE-07-SUAS - System, Small Unmanned Aircraft and recipients/sub-recipients are prohibited from purchasing this equipment using any FEMA Preparedness Grant funds. Prior approval requirements for this category will be updated once available." Federal Emergency Management Agency, "DHS Authorized Equipment List," May 7, 2015, <https://www.fema.gov/authorized-equipment-list-item/03oe-07-suas>.

¹⁶³ Steve Grazier, and Loren Genson, "Medina County Sheriff's Office Drones Cleared for Flight," *The Medina County Gazette*, February 14, 2013, <http://medinagazette.northcoastnow.com/2013/02/14/medina-county-sheriffs-office-drones-cleared-for-flight/>.

With a lack of funding posing a significant barrier for implementing a UAS program in many cases, this thesis encourages departments to consider the procurement of small UASs as a means to mitigate or reduce this barrier. Small UASs weighing less than 5 pounds (2.2 kg), are significantly less expensive, and are more rapidly deployable than larger UASs, which is an area of consideration when developing a UAS program. There are limitations with small UASs, which are discussed in the decision guide in Appendix A; yet, they may prove to be the most viable option for local agencies and organizations developing a UAS program.

Lastly, it is worth noting that while FEMA is awaiting the implementation of recommendations by the White House Law Enforcement Working Group, law enforcement is but one component of a domestic UAS program. Failing to recognize this limits the use of UASs by what is arguably FEMA's largest constituency— local and state emergency management agencies. The lack of recognition afforded emergency management as a significant component of the domestic UAS community is not limited to federal agencies or executive orders, but it is also reflected in state legislation and local ordinances as well.

Chapter VI of this thesis references state legislation pertaining to UASs in the states of Alaska, Illinois, North Dakota, and Tennessee. In each instance, the UAS legislation focuses on a law enforcement perspective, not those for disaster response. While research did not determine a clear conclusion as to why that is the case, it may be due to law enforcement missions having more public recognition and concern about their use. Nonetheless, recognition of emergency management as an equal constituent in the UAS community is critical for public safety. Local ordinances, state legislation, executive orders, and FAA rules and regulations should recognize the criticality of UASs for disaster response missions by including processes to expedite their implementation into the NAS.

VI. POLICY AND PROGRAM CONSIDERATIONS FOR A DISASTER RESPONSE UAS PROGRAM

Read not to contradict and confute; nor to believe and take for granted; nor to find talk and discourse; but to weigh and consider.

— Francis Bacon, English philosopher and statesman

A. POLICY CONSIDERATIONS

For those agencies and organizations looking to establish a UAS program, executive level buy-in is critical to the establishment and success of the program. Without buy-in from the chief executives and elected officials of the jurisdiction, there is little use to proceed with implementing a UAS program as executive support is required to sustain the program. Therefore, it is critical to provide comprehensive programmatic information to senior officials so they can make an informed decision when considering a UAS program.

Critical information for any agency or organization considering a UAS program includes having an understanding of the following: information needs, a historical perspective of the conventional methods used in aerial missions for disaster response, an awareness of comparative programs, potential uses of UASs for disaster response, and barriers impacting the formal integration of UASs into the NAS for disaster response missions. Assuming for the purposes of this thesis that a decision has been made to implement a UAS program, the agency or jurisdiction should first develop a policy that outlines the parameters of the program before procuring a UAS and/or formally establishing a program. Currently, there is no standardized national format for a UAS program policy, but there are certainly general topic areas that should be addressed as part of a formal policy.¹⁶⁴ Though not entirely inclusive, these topics are detailed below.

¹⁶⁴ There is no national standard or template for UAS policies in place as of the date of this thesis. General information for this section is based on the Medina County, OH Sheriff's Office UAS policy.

Recognizing public concerns regarding the use of UASs by law enforcement and homeland security agencies, the purpose section of the policy should reinforce the humanitarian nature of the program and reinforce its benefit to public safety. The purpose section should also discuss why a UAS program is to be implemented by the agency or jurisdiction. Additionally, due to the aforementioned barriers concerning privacy and surveillance, it would be beneficial to specifically reference the policy is for an emergency management UAS program. The purpose section of the policy should also reference compliance with FAA rules and regulations and reinforce safeguarding the privacy of the general public.

The definitions section of the policy is important as it identifies key positions and terms that are applicable to the program. Many of the terms, such as the PIC, visual observer, sensor/payload operator, AGL, and visual flight rules are identified in the COA issued by the FAA while other terms and positions (e.g., flight leader), though general in nature, will be defined by the agency or jurisdiction. Any terms referenced in the policy should be noted in this section of the policy to ensure the use of standard terminology within the UAS program.

The aircraft section of the policy should specifically address the type(s) of UAS(s) that will be used by the agency or jurisdiction. At a minimum, the topics that should be included in this section of the policy include general airworthiness, maintenance, maintenance logs, training (both pre-service and ongoing in-service), radio frequencies that will be used, storage, transportation, pre-flight preparation (e.g., charging batteries, initiating power source), post-flight recovery, and approved payload (e.g., camera, environmental sensors). This information is critical as it establishes many of the basic elements that form the foundation of a UAS program.

In addition to noting the specifications of the UAS(s) operated under the program, the specifications section of the policy should include provisions noting the UAS may not under any circumstances be armed with lethal or less lethal weapons. The FAA has traditionally opined that laws related to local and state

law enforcement “are not subject to federal regulation,”¹⁶⁵ although the previous director of the FAA’s UAS Integration Office stated the current FAA rules “would prohibit weapons from being installed on a civil aircraft.”¹⁶⁶ While there is pending legislation in Tennessee affirming such a prohibition against the attachment of weapons to a UAS, this exclusion would not apply to local, state, or federal law enforcement agencies.¹⁶⁷ Conversely, the state of North Dakota has enacted legislation prohibiting the arming of all UASs with lethal weapons; however, the legislation does not specifically prohibit the use of less lethal weapons (e.g., Tasers, bean bag rounds, pepper spray).¹⁶⁸ The topic of arming UASs in the NAS of the United States is a controversial topic, which highlights the need for an emergency management UAS program policy explicitly prohibiting the weaponizing of UASs.

Cyber security is a critical area necessitating inclusion in the agency or jurisdiction’s UAS policy and standard operating procedures (SOPs). This is supported by Spirik, who asserts that many commercial off-the-shelf (COTS) UASs lack the technological maturity necessary to prohibit cyber intrusion.¹⁶⁹ To address the cyber threat posed to UASs, researchers from the University of Virginia and the Georgia Institute of Technology developed the System-Aware Secure Sentinel system.¹⁷⁰ During flight tests, researchers were able to detect

¹⁶⁵ Federal Aviation Administration, “State and Local Regulation of Unmanned Aircraft Systems (UAS) Fact Sheet,” news release, December 17, 2015, https://www.faa.gov/uas/regulations_policies/media/UAS_Fact_Sheet_Final.pdf.

¹⁶⁶ Ben Wolfgang, “FAA Official: No Armed Drones in U.S.,” *Washington Times*, last modified February 13, 2013, <http://www.washingtontimes.com/news/2013/feb/13/faa-official-no-armed-drones-us/?page=all>.

¹⁶⁷ Dave Boucher, “Tennessee Bill Would Ban Guns on Drones, Except for Police,” *The Tennessean*, last modified December 28, 2015, <http://www.tennessean.com/story/news/politics/2015/12/28/tennessee-bill-would-ban-guns-drones-except-police/77880868/>.

¹⁶⁸ H.R. 1328, 64th Leg. Assem. (2015).

¹⁶⁹ Petr Spirik, “Application of Unmanned Aerial Vehicles in Cyber Operations” (master’s thesis, University of Liverpool, 2014), 41.

¹⁷⁰ Josie Pipkin, “U. Va. Technology Proves Effective in Thwarting Cyber Attacks on Drones,” University of Virginia, last modified January 23, 2015, <https://news.virginia.edu/content/uva-technology-proves-effective-thwarting-cyber-attacks-drones>.

and mitigate cyber-attacks, thereby restoring full flight operations to the UAS.¹⁷¹ As technology continues to evolve, the development of a variety of cyber protection systems is expected, much like what exists today with virus protection security packages for computers and smartphones. In recognition of the implications of cyber hacking, provisions should be in place to prevent the compromise of UAS mission information and the commandeering of UASs by a third party. In addition to incorporating cyber security provisions into UAS policies and SOPs, UAS programs should conduct routine preparedness exercises to validate the cyber security of their program.

The PIC section of the policy should address the pilot rating requirements, initial and in-service training and certification requirements, ongoing/re-certification requirements, flight requirements, and physical requirements. These topical areas are not only required by the FAA, but they also are necessary from a liability perspective as they provide the competencies that are required to operate a UAS within the parameters of the agency UAS program. As with any perishable skill, it is critical for the pilots to maintain their flying proficiency, and a minimum number of flight events should be identified as a monthly or annual requirement.

As with the PIC section of the policy, there should be a section of the policy outlining the roles and responsibilities of the flight crew. For example, the visual observer and sensor/payload operator positions should be outlined in the policy, including an identification of initial and in-service training requirements, as well as pre-flight, flight, and post-flight duties and responsibilities.

In addition, the policy should contain a flight conditions and operating guidelines section. These sections should address hours of operation (e.g., daytime only, daytime and night operations) and if there are any special requirements for night operations or limited visibility situations (e.g., fog). Line-of-sight requirements, altitude, and weather (e.g., hot, cold, wind speed limitations)

¹⁷¹ Ibid.

should also be addressed in the policy to ensure a standard is set for when the UAS can and cannot be deployed. If there are overriding situations (e.g., life safety) that necessitate a deviation from policy, the parameters, including approval authority for the deviation, should be clearly indicated in the policy.

A section of the policy should also outline the flight requirements, including how mission requests will be submitted, approved, assigned, completed, and validated. Minimum staffing for the flight crew should be identified and must be in accordance with (IAW) the COA, or its equivalent authorization, issued by the FAA. Additionally, pre-flight, flight, and post-flight requirements should be outlined, including a safety check to ensure the takeoff, area of operation, and landing zones are clear and operationally safe.

Additionally, a process for notifying local air traffic control, if appropriate, should be outlined in policy. At a minimum, a notice to airmen transmission should be made by the UAS ground station advising of a pending or ongoing flight operation. It is critical for all transmissions, coordination, and flight information to be documented and the process for doing so should be clearly articulated in a UAS program policy.

To ensure there is delineation between law enforcement, homeland security, and emergency management missions, the policy should reflect an emergency management nexus. As such, the policy should contain a prohibitions section outlining unauthorized activities, including, but not limited to, law enforcement surveillance, traffic enforcement, and crime monitoring. With 51 percent of those polled in a Monmouth University poll doubting that law enforcement agencies will use UASs appropriately, it is critical for emergency management agencies to ensure their UAS policies have clearly defined privacy protections in place.¹⁷² This provision is critical in establishing the non-intrusive intent of an emergency management UAS program.

¹⁷² Monmouth University, *National: U.S. Support Unarmed Drones*.

Additionally, the policy should contain a prohibitions section reinforcing that the operation of the UAS will be IAW the limitations of the aircraft, identifying the operational air space and perimeter area requirements, outlining emergency call off/mission abort procedures, and a prohibition against operating UASs in the immediate area of manned aircraft. These prohibitions should be clearly identified in the policy and part of the training provided to all UAS crewmembers and agency leadership/management staff.

Documentation for all aspects of the UAS mission must be maintained. The information captured for documentation must be comprehensive, accurate, and archived IAW the retention policy of the agency or jurisdiction. The documentation will need to be submitted to the FAA on a regular basis (e.g., monthly or quarterly) IAW the provisions of the COA or its equivalent authorization. The documentation section should also outline notification requirements for contacting the FAA, as well as the appropriate local and state agencies, in the event of a UAS emergency or UAS crash, including near-miss incidents.

A critical consideration of any UAS policy concerns record retention and access to information. The timeframe for retention will vary jurisdiction by jurisdiction and is a local management decision. Due to the potential for litigation arising from actions taken or not taken during and in the aftermath of a disaster, the legal staff of the agency or jurisdiction maintaining ownership of the UAS program should be involved in crafting the parameters of the retention section of the policy. The decision may be to use the agency or jurisdiction's standard retention policy or a specific retention policy may need to be developed as it pertains to any video, audio, or other data (i.e., environmental sampling telemetry) collected by UAS operations. When determining the retention period, agencies should review any existing retention policies for similar missions that have been performed by conventional rotary and/or fixed-winged aircraft for applicability.

Agencies should differentiate between tangible, mission-related flight data and data collected during training, exercises, and other non-mission flights. For example, the state of Alaska prohibits law enforcement agencies from retaining images obtained during a UAS mission unless “required as part of an investigation or prosecution; for training purposes; or by federal or state law or by municipal ordinance.”¹⁷³ Additionally, the state of Illinois has enacted record retention legislation requiring law enforcement agencies to destroy all data collected via UAS within 30 days of acquisition unless “there is reasonable suspicion that the information contains evidence of criminal activity, or...the information is relevant to an ongoing investigation or pending criminal trial.”¹⁷⁴ While the aforementioned legislation does not directly apply to emergency management specific UAS missions, there is some applicability. Generally speaking, data not collected during an actual disaster response mission, or if the mission results in a lack of usable data, should be securely discarded within a reasonable timeframe (i.e., 72–96 hours).

Access to the data collected during UAS operations must be addressed to ensure adequate provisions are in place to protect the information from unauthorized disclosure. Even though many Americans engage in risky behavior via their smartphones by accessing non-secured data networks or downloading apps from non-official app stores,¹⁷⁵ there are significant concerns regarding the use and disclosure of information obtained via a UAS, regardless of the intent of the mission. Irrespective of expressed concern, it is incumbent upon government agencies to implement a policy that limits disclosure of information accessed during UAS missions to those agencies and organizations possessing a need to know.

¹⁷³ H.R. 255 (2014).

¹⁷⁴ Freedom from Drone Surveillance Act, Pub. L. No. 098-0569 §20 III (2013).

¹⁷⁵ Tracey Lien, “How Smartphone Users Are Making Silly and Unsafe Choices,” *Los Angeles Times*, March 24, 2015, <http://www.latimes.com/business/technology/la-fi-tn-mobile-privacy-risk-20150324-story.html>.

Absent local ordinances and/or state statutes, President Obama's February 15, 2015 memorandum on UASs specifically provides guidance for disclosure by stipulating,

UAS-collected information that is not maintained in a system of records covered by the Privacy Act shall not be disseminated outside of the agency unless dissemination is required by law, or fulfills an authorized purpose and complies with agency requirements.¹⁷⁶

Emergency management missions, as previously noted, vary significantly in their intent versus law enforcement and/or homeland security centric missions. As such, their acceptance by the general public for domestic use in the NAS of the United States hinges heavily on the recognition of their non-intrusive, humanitarian use as a life-saving resource.

Related to the disclosure of UAS data is the provision for public records requests that may be initiated by the media or general public. With the evolving nature of UASs and the prevalence of their use considered as a newsworthy event by the media, any UAS policy should include provisions for how public records requests will be handled. While the procedures may be consistent with existing processes for handling requests submitted under the Freedom of Information Act (FOIA), agencies and jurisdictions need to consider if data gathered under disaster response missions warrant special protection. While some may argue that data should be released via a FOIA request regardless of the agency obtaining the data, disaster response missions should be afforded an exemption for any photos, audio recordings, or videos obtained during or in the aftermath of a catastrophic event involving mass casualties or mass fatalities due to the potential graphic nature of the information obtained.

Based on the level of the transparency that is expected of government agencies, an annual report should be developed and made accessible for public review. The requirement to publish an annual report should be contained within

¹⁷⁶ "Promoting Economic Competitiveness."

the agency or jurisdiction's UAS policy. At a minimum, the report should address the number of training and mission flights conducted, the number of flights that resulted in information being obtained and stored, the disposition of that information, training completed by the flight crew(s), and the approximate cost to operate the program.

Lastly, the UAS policy should address risk management processes concerning the insurance liability of the jurisdiction operating the UAS. While many jurisdictions are self-insured, they should determine if additional liability insurance from a private insurance company is necessary as part of their risk management program. Regardless of whether specific insurance for the UAS program is obtained from a private insurance company or if the liability for operation is covered under the jurisdiction's self-insured risk management program, the UAS policy should reflect the type of liability coverage in effect.

B. PROGRAM CONSIDERATIONS

As noted previously, due to the nature of disaster response UAS missions, there are inherent differences between emergency management missions, military, law enforcement, and/or homeland security missions. As such, it is important to identify design considerations that should be considered when selecting a UAS platform for disaster response missions. While technology is continually evolving, the general design considerations should remain consistent.

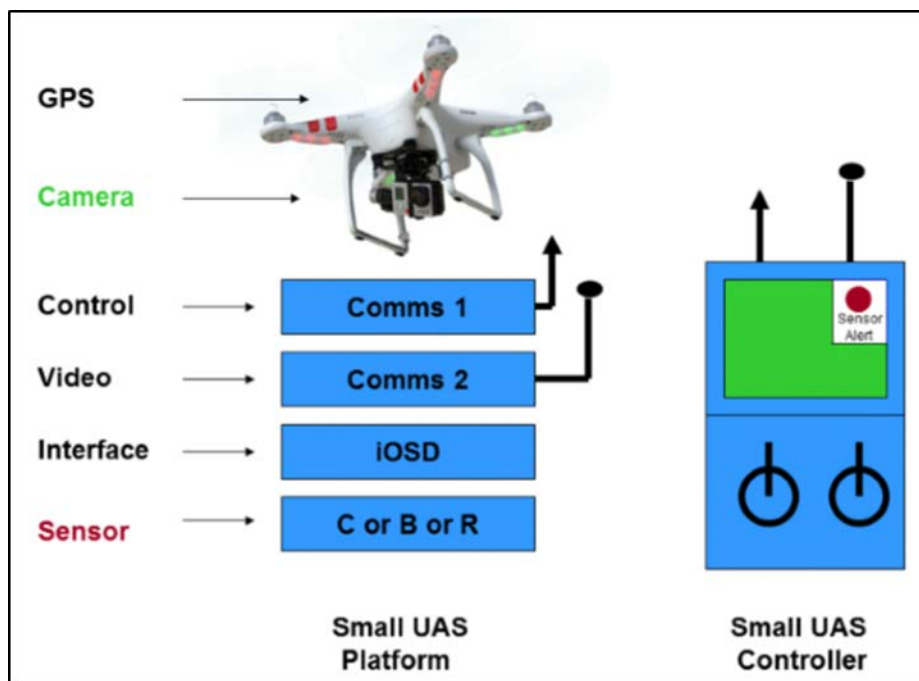
1. UAS Design Considerations

One of the first program considerations should be the type and size of UAS identified for use in the program. The release of FAA rules and regulations for UASs may very well impact the decision on the type of UAS used if, for example, the restrictions are more favorable toward small UASs (i.e., 5 pounds or less) than larger UASs (i.e., 55 pounds or more). Factors to consider when agencies are determining the type of UAS to procure include a navigation system that will return the unit to its home base when battery power gets low or the system loses signal with the PIC. Additionally, as noted in the Policy

Considerations section of this thesis, cyber provisions should be in place to prevent mission information from being compromised as well as to protect the platform from being commandeered by a third party.

Moreover, it is critical for agencies to determine the information needs that exist as those needs will assist in determining the payload requirements of the UAS. For the purposes of this thesis, “payload” refers to, but is not limited to, sensory packages (e.g., forward looking infrared [FLIR], weather, environmental sampling), audio packages, and cameras (e.g., still-frame, video, hyperspectral imaging) that can be attached to a UAS. Whether the payload requirements result in the procurement and operation of multiple UASs or a single platform with multiple capabilities is a determination that will need to be made by each agency or jurisdiction based on available funding and the allowable provisions of its COA or FAA authorization. A sample sensory integration diagram for a COTS UAS is depicted in Figure 5. Additionally, an example of a relatively low-cost, lean-sensing environmental detection payload using a COTS UAS platform carrying a HazMat test strip is noted in Figure 6.

Figure 5. A Sample Sensory Integration Diagram of a COTS UAS



Source: H. Wang, Coorg R. Prasad, and Robert M. Serino, "Lean Sensing: Intelligent, Low-Cost, Remote Detection by Integrating Currently Available Components for Distant Early Warning," *The Journal of the Homeland Defense and Security Information Analysis Center* 2, no. 1 (2015): 16.

Figure 6. UAS with a Low-Cost Environmental Detection Payload



Source: Wang, Prasad, and Serino, "Lean Sensing," 16.

The benefit of using a COTS UAS system such as the one noted in Figure 6 is that it is a relatively low-cost system that is deployable in practically any HazMat situation. In this particular scenario, the unit could be landed on the chemical hazard in question and transmit video of the sampling paper, thereby indicating the hazard present without placing emergency responders in a hazardous environment. The platform could then, if necessary, be disposed of as hazardous waste without a significant cost to the agency or jurisdiction.

Another area some agencies and jurisdictions have considered for their UAS program is whether the platform will be tethered or untethered. Regardless of whether the UAS is tethered or untethered, there is still a requirement to obtain a §333 approval from the FAA, including the issuance of a COA. Table 2 notes some pros and cons to consider when weighing the decision as to whether to pursue a tethered or untethered UAS.

Table 2. Pros and Cons of Tethered versus Untethered UASs

Pros	Cons
Increased flight time	Restricted mobility and range
Increased data transmission rates	Restricted operational environment
Increased flight control and safety	Tether can become tangled
Limits opportunities to hack system	More ground-infrastructure required
Increased privacy protection	Electrocution hazard

Source: Jack Nicas and Tarun Shukla, "Some Drones Are Put on a Leash," *Wall Street Journal*, August 2, 2015, <http://www.wsj.com/articles/some-drones-are-put-on-a-leash-1438557521>.

In addition to tethering options, some agencies have taken a different approach and have obtained blimps to perform aerial reconnaissance. Blimps possess similar capabilities and pros/cons in comparison to those of a tethered UAS. While standard UASs, whether tethered or not, require an FAA COA to operate, a blimp, such as one operated by the Ohio Department of Transportation (ODOT), is classified as a moored balloon and does not require

FAA approval to operate.¹⁷⁷ As such, blimps are deployable without the requirement of obtaining a COA from the FAA. However, “surveillance blimps” are not without limitations and, as such, present potential concerns necessitating consideration before procuring such a system. For example, the deployment of a surveillance blimp to assist with a manhunt in Pennsylvania in October 2014 was taken out of service after being considered ineffective due to the terrain and tree canopy in the search area.¹⁷⁸ In addition to operational limitations, blimps such as ODOT’s are costly to purchase at approximately \$180,000 each, not including the cost to fill the blimp with helium prior to deployment, which is in excess of \$1,000. Prolonged deployments require additional helium to maintain operations.¹⁷⁹ As costs are a significant factor for agencies and jurisdictions to consider when making the determination of whether to implement a UAS program, blimps may prove to be cost prohibitive, especially when funding sources to establish a UAS program may be limited. While costs associated with most technologies decrease over time, there is no significant evidence indicating an anticipated decrease in surveillance blimp costs in the near future.

Additionally, while blimps have been hailed as a safer alternative to untethered UASs, they are not infallible as evidenced by the October 2015 untethering of a U.S. Army surveillance blimp from its moorings at the Aberdeen Proving Grounds in Maryland.¹⁸⁰ With the potential liability of an untethered, non-controllable blimp, agencies and jurisdictions need to factor liabilities into their decision concerning which platform(s) should be included in their UAS program.

¹⁷⁷ Dominic Binkley, “Ohio Buys ‘Blimp in a Box’ for Surveillance,” *The Columbus Dispatch*, July 21, 2014, <http://www.dispatch.com/content/stories/science/2014/07/20/blimp-in-a-box.html>.

¹⁷⁸ Cyrus Farivar, “Pennsylvania State Cops Borrow, Then Return, Spy Blimp to Aid Manhunt,” *Ars Technica*, October 29, 2014, <http://arstechnica.com/tech-policy/2014/10/pennsylvania-state-cops-borrow-then-return-spy-blimp-to-aid-manhunt/>.

¹⁷⁹ Binkley, “Ohio Buys ‘Blimp in a Box’ for Surveillance.”

¹⁸⁰ “Military Blimp Comes Loose in Maryland, Monitored by Fighter Jets over Pennsylvania,” *CBS News*, October 28, 2015, <http://www.cbsnews.com/news/military-blimp-maryland-fighter-jets-pennsylvania/>.

2. Organizational Structure and Support

The implementation of a UAS program represents a significant investment in personnel, equipment, training, and funding for the agency or jurisdiction looking to establish the program. As previously noted, regardless of the organization, there must be support for a UAS program at the highest levels of the organization for it to succeed. Although UAS support may be available from the federal government by tasking agencies such as CBP or DSCA mission assignment to DOD assets, UAS programs implemented at the local level of government offer the quickest response option. As such, this thesis promotes the establishment of disaster response UAS programs within local or county EMAs and/or within state-level EMA regional offices.

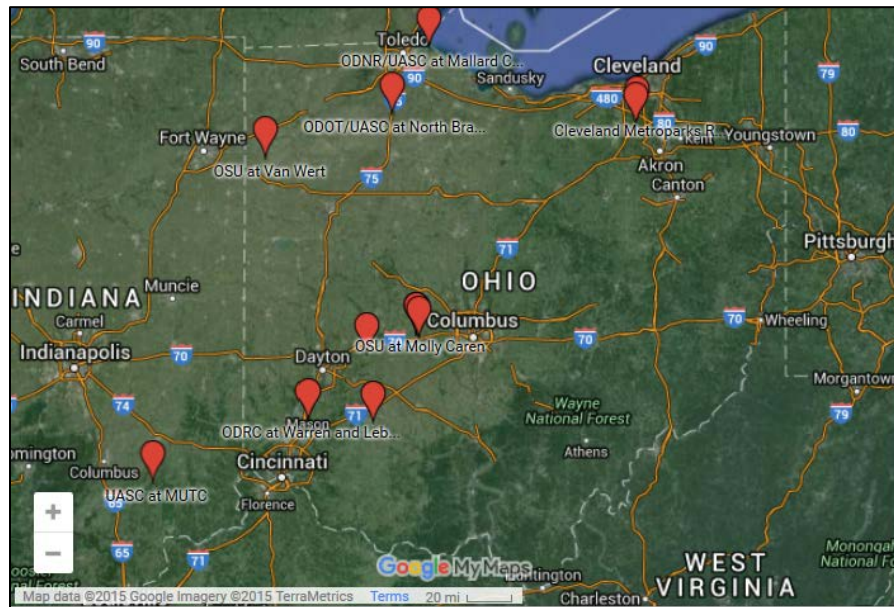
If available, a UAS advocate is an asset who can assist with establishing a UAS program. For example, states such as Ohio, in partnership with the state of Indiana, have established a UAS center focused on “advanc[ing] the commercialization of technology through research, design, testing, and evaluation and the subsequent certification of systems or system components and supporting the UAS community in research and development, facilitating safe integration into the [NAS].”¹⁸¹ While not an operational component, the Ohio/Indiana UAS Center is a valuable resource that supports the expansion of UASs in the NAS of the United States for public and private operations. A significant benefit of the Ohio/Indiana UAS Center is the pre-establishment of multiple COAs that provide venues for UAS flight testing and evaluation (see Figure 7). Another example of a UAS test center is at the New Mexico State University, which has an approved COA for a test area encompassing over 15,000 square miles (see Figure 8).¹⁸² Agencies and jurisdictions establishing a

¹⁸¹ Ohio Department of Transportation, “About the Ohio/Indiana Unmanned Aircraft Systems Center,” accessed November 30, 2015, <http://www.dot.state.oh.us/Divisions/uas/Pages/About.aspx>.

¹⁸² New Mexico State University, “21st Century Aerospace: The UAS FTC: Your Gateway to the National Airspace System,” accessed December 21, 2015, <https://psl.nmsu.edu/The%20UAS%20Flight%20Test%20Center>.

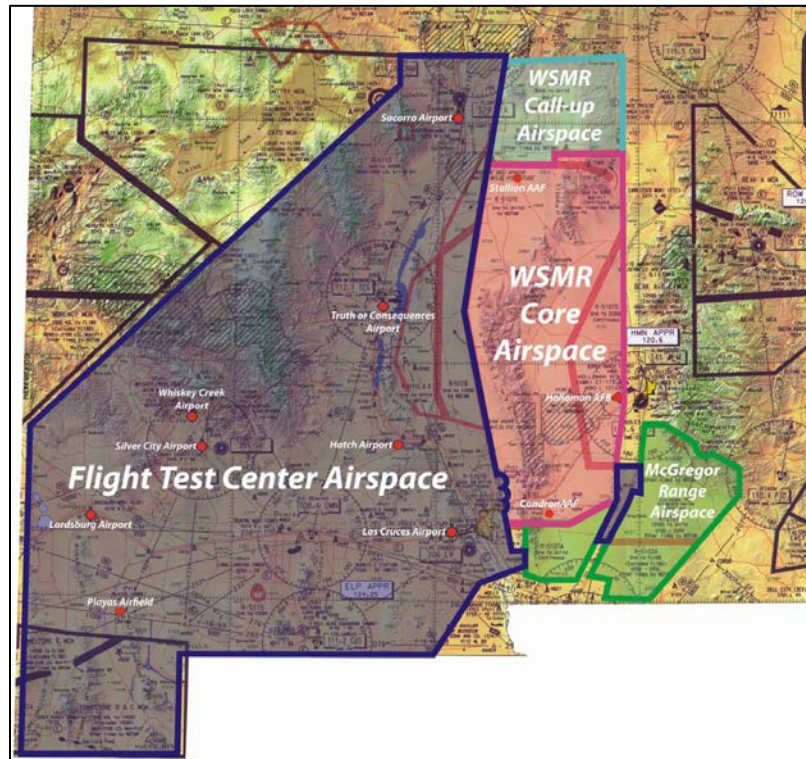
UAS program should look toward similar centers, if they exist, in their respective states, which may be able to assist with the establishment of their program.

Figure 7. Ohio/Indiana UAS Center Approved COAs



Source: Ohio Department of Transportation, "About the Ohio/Indiana Unmanned Aircraft Systems Center," accessed November 30, 2015, <http://www.dot.state.oh.us/Divisions/uas/Pages/About.aspx>.

Figure 8. New Mexico State University Approved COA



Source: New Mexico State University, "21st Century Aerospace."

Due to requirements of a UAS program, it may be beneficial to develop the program as a regional asset that could deploy anywhere within a given region or state. The development of a regional program would be beneficial in those areas that do not have sufficient funding and resources to develop a jurisdiction specific disaster response UAS program. While the deployment of a regional asset could take more time to deploy than a single jurisdictional asset, it would likely be available for mission assignment significantly quicker than many state-level UAS assets.

The development of a regional UAS program would require a memorandum of understanding between the counties or agencies that comprise the program. There is a basis for developing regional teams and programs as many states, including Florida, Indiana, North Carolina, Ohio, Oklahoma, and Texas, maintain regional HazMat teams, swift water rescue teams, emergency

ordnance disposal teams, special response teams, communication assets, and medical response teams. While different than a UAS program, the basic foundation and procedures for establishing these teams is transferrable regardless of the capability fielded.

Regardless of the decision to develop a single jurisdiction or regional UAS program, one significant topic for consideration would be the types of missions performed by the UAS. As evidenced earlier in this thesis, there are significant concerns regarding the use of UASs for law enforcement and/or homeland security related missions. As such, separate operational parameters and record retention standards would need established, including the handling of potential criminal indicators, crimes, or crime scenes (e.g., marijuana growing operations) that may be inadvertently observed during a disaster response mission.

3. Funding

Before a UAS program can be developed and implemented, a dedicated funding stream for operational and sustainment costs must be identified. As mentioned in the Barriers Complicating the Use of UASs section of this thesis, funding for UASs is theoretically available through the EMPG, SHSP, and UASI grants as UASs are an eligible expenditure and listed as such on DHS' AEL. However, funding for UASs under these programs is currently curtailed¹⁸³ and as such does not represent a viable funding option at this time. Therefore, agencies and jurisdictions may need to identify other funding streams (e.g., general revenue funds) or methods (e.g., donations) to obtain a UAS. In addition to the procurement and maintenance costs for a UAS, agencies and jurisdictions would need to factor in staff costs associated with meeting certification, training, and operational requirements.

¹⁸³ Federal Emergency Management Agency, "FEMA Approved Equipment List," accessed December 21, 2015, <https://www.fema.gov/authorized-equipment-list-item/03oe-07-suas>.

With literally hundreds of UAV platforms to choose from when establishing a UAS program,¹⁸⁴ a comprehensive review should occur prior to procuring a UAS. As an example, the cost of the latest generation DJI Phantom Professional Quadcopter with a 4K camera is approximately \$1,200.00.¹⁸⁵ This represents a minimal investment for many jurisdictions and could serve as a base-model UAS, primarily focused on video reconnaissance and low-level environmental detection via HazMat detection strips. However, mounting options exist for attaching additional sensors to the quadcopter, if available and within the lift parameters of the platform. Research on the price of UASs used by governmental agencies reveals costs ranging from \$0.00 in Medina County, OH, where two UASs were donated to the Medina County Sheriff's Office, to \$160,000 for an Aeryon SkyRanger purchased by MSP, to \$31 million for the Predator-B operated by CBP.¹⁸⁶ Such a wide range of pricing indicates the multitude of UAS options currently available, with the number of options and manufacturers expected to increase exponentially once the FAA finalizes the UAS rules and regulations.

4. Training and Maintenance

Each agency or jurisdiction operating a UAS program must ensure pre-service and in-service training requirements are met and maintained. While to date there has been a lack of clear-cut guidance from the FAA, the Frequently Asked Questions section of the UAS portion of the FAA's website notes:

Pilot certification requirements for petitions for exemption under Section 333 are evaluated on a case-by-case basis. While Section 333 grants the Secretary of Transportation flexibility with regard to airworthiness certification requirements, it does not grant the Secretary any flexibility with regard to airman certification standards

¹⁸⁴ Amazon, "DJI Phantom 3 Professional Quadcopter 4K UHD Video Camera Drone," accessed November 29, 2015, <http://www.amazon.com/DJI-Phantom-Professional-Quadcopter-Camera/dp/B00VSITBJO>.

¹⁸⁵ Ibid.

¹⁸⁶ Grazier and Genson, "Medina County Sheriff's Office Drones Cleared for Flight;" Michel, "Customs and Border Protection Drones;" Gus Burns, "Michigan State Police Receive Federal Authorization to Fly Drones on Law Enforcement Missions," *MLive*, March 9, 2015, http://www.mlive.com/news/detroit/index.ssf/2015/03/michigan_state_police_receive.html.

as outlined in Sections 44703 and 44711 of Title 49 of the United States Code (49 USC). An FAA airman certificate is required to operate an aircraft in the National Airspace System.¹⁸⁷

As previously mentioned, the interpretation espoused by the FAA, that a UAS operated by a civilian hobbyist is not an aircraft but one operated by a government agency is, represents a clear contradiction in logic that must be addressed if UASs are going to be used to their full potential. Absent the FAA waiving the airman certificate, government agency UAS operators or PICs and visual observers must possess an airline transport, commercial, private, recreational, or sport pilot certificate if operating a UAS in the NAS. Due to evolving FAA UAS rules and regulations, agencies and jurisdictions establishing a UAS program should contact the FAA's UAS Integration Office for the latest training and certification requirements.

In addition to formal FAA PIC and visual observer certification requirements, agencies should implement internal training requirements, including identifying a requisite number of flights that must be completed by a PIC and visual observer prior to becoming operationally deployable, as well as to maintain their current certification. Additionally, training should be provided for sensor/payload operators as well. Absent an FAA or national standard, agencies should develop the standard for training and document the training accordingly. As with the PIC and visual observer certification requirements, agencies should maintain routine contact with the FAA's UAS Integration Office to ensure compliance with existing training and certification requirements.

As with any operational program involving equipment, maintenance is an area that must be included in any UAS program. As observed by Hobbs and Herwitz, UASs have a higher accident rate than traditional rotary and fixed-

¹⁸⁷ Federal Aviation Administration, *Fact Sheet—Unmanned Aircraft Systems (UAS)*.

winged aircraft; however, the majority of accidents are due to human error.¹⁸⁸ Hobbs and Herwitz further advance that unlike manned aircraft, “UAV operators must ensure the reliability of an entire system that comprises the vehicle, the ground station, and communication equipment.”¹⁸⁹ As such, maintenance is a critical safety component necessitating guidance in the UAS program policy and SOPs. Unless the agency fielding the UASs has maintenance staff with UAS maintenance experience or maintenance contracts in place, it is recommended that any maintenance exceeding preventative and basic upkeep (e.g., cleaning, tightening screws, attaching payload packages) be performed by the UAS manufacturer, especially concerning the maintenance of any electrical components. Additionally, the program policy and SOPs should require the completion and retention of maintenance logs for all repairs and maintenance performed on the UAS(s). Lastly, agencies should maintain routine contact with the FAA’s UAS Integration Office to ensure compliance with any maintenance recommendations or requirements established by the FAA.

¹⁸⁸ Alan Hobbs, and Stanley R. Herwitz, *Human Factors in the Maintenance of Unmanned Aircraft,” Technical Report, Office of the Chief Scientist for Human Factors, Unmanned Aerial Vehicles Human Factors: Program Review FY05*, Federal Aviation Administration, 2005, http://www.faa.gov/about/initiatives/maintenance_hf/library/documents/media/human_factors_maintenance/maint_binder.pdf, 1.

¹⁸⁹ Ibid.

VII. THE WAY FORWARD

That's one small step for man, one giant leap for mankind.

— Neil Armstrong, astronaut

A. SUMMARY

Emergencies and disasters provide an environment that is conducive to the use of UASs to support the efforts of emergency responders deploying for such events. As repeatedly indicated in this thesis, significant mission, life-saving, and resource benefits exist for the use of UASs in emergency management. The costs of UASs, especially small UASs, are significantly less than the cost of conventional rotary and fixed-winged aircraft, not to mention they are safer. If for no other reason than cost alone, the use of UASs should be considered by governmental agencies when evaluating areas in which they can streamline operational costs and increase efficiency. For example, as previously noted, the deployment of UASs is often more rapid than other platforms, and critical flight data can be provided more expeditiously to ICPs and EOCs as well. An additional benefit of using UASs during disasters is the fact they are expendable, whereas emergency responders are not.

As it pertains to UASs, emergency management is at a crossroads. The evolving technology offered by UASs can either be embraced and used to enhance disaster response or the use of existing platforms can continue. As established in this thesis, there are multiple barriers that limit the use of UASs in the NAS; however, none of these barriers are insurmountable. With an opportunity to be on the leading edge of the UAS revolution, it is an exciting time to be in emergency management. The author argues that EMAs should move forward with the establishment of UAS programs for disaster response by embracing UAS technology and the many benefits it offers for mitigation, preparedness, response, and recovery operations.

B. RECOMMENDATIONS

The use of UASs for disaster response missions offers a significant enhancement to the capabilities of emergency responders as they provide for the safety of the general public. As such, the integration of UASs into the emergency management and first responder disciplines must be a priority for the FAA, as well as local and state governments. This thesis offers seven recommendations, focusing at the local, state, and federal levels, with the most comprehensive recommendation calling for the establishment of a new office within the FAA that is responsible for coordinating governmental UAS programs with local and state government agencies. These recommendations are outlined below.

1. Conduct of a Feasibility Study Prior to Implementation

While this thesis argues the benefits of a UAS program for disaster response, any agency or jurisdiction considering the establishment of a UAS program for disaster response missions, or any mission for that matter, should convene a feasibility study to evaluate the need for such a program. A UAS program should not be established simply for the sake of doing so or because it is perceived as the latest innovation in disaster response. Factors to consider, listed in no particular order, include: agency and administration support; legalities; organizational costs, assignment, and administration; cost analysis of UAS missions in comparison to conventional rotary and fixed-winged aircraft; flight crew staffing and certification requirements; FAA approval processes; funding stream and procurement processes; training; maintenance; long-term sustainability; public perception and education; and the size/type of UAS needed (e.g., small UAS).

If the feasibility study determines the implementation of a UAS program is not practical, then there is no need to proceed with any further action; however, if the study determines there is an existent need to implement a UAS program, the agency or jurisdiction should proceed with developing a policy to serve as the

basis of the program. That policy should be included with any approval or authorization requests (e.g., COA) that is submitted to the FAA.

2. Program Funding

Whether new or a reallocation from existing programs, a dedicated funding source to implement a UAS program is necessary for procurement and sustainment of the program. While some agencies and jurisdictions are fortunate enough to have funding in their existing budgets to allocate for a UAS program, the reality is many do not. The EMPG and HSGP are two examples of funding that can be potentially be used to implement a UAS program.

As noted previously, even though UASs are an authorized item on the AEL, FEMA is not currently funding their procurement pending the implementation of recommendations from the White House Law Enforcement Working Group. The lack of funding approval by FEMA for UASs is to some degree understandable due to a lack of progress by the FAA on issuing rules and regulations for public sector use; however, the fact remains that UASs are an allowable item under both the EMPG and HSGP. While FEMA has temporarily suspended the approval of UAS funding requests pending the aforementioned implementation of recommendations, FEMA needs to recognize the use of UASs is not solely for law enforcement missions. While some may argue that FEMA is aware of this, its focus, at least to this point, has been on the law enforcement application of UASs, not the humanitarian application offered by emergency management UAS programs.

Additionally, once the stay on funding for UASs is removed, purchasing options under the HSGP are somewhat restricted, as the grant currently requires a terrorism nexus for funds expended under the grant.¹⁹⁰ It is time the HSGP evolves to fully incorporate an all-hazards approach that recognizes the need to provide funding for disaster response missions sans the requirement of a linkage to terrorism preparedness. By recognizing an all-hazards approach to

¹⁹⁰ Homeland Security Act of 2002, Pub. L. No. 107-296, 116 Stat. 2135, 107th Cong. (2002).

preparedness, the HSGP could provide a valuable funding stream for local governments to leverage as they establish and sustain a UAS program; however, the expansion of funding to support an all-hazard approach for equipment such as UASs is not a FEMA decision and must be addressed by Congress when allocating funding for the HSGP.

Notwithstanding the current provision of the HSGP that limits funding to equipment with a clear nexus to terrorism, the EMPG contains provisions authorizing the procurement of equipment for local and state EMAs. The EMPG, which “provides federal funds to states to assist state, local, territorial, and tribal governments in preparing for all hazards,” contains a provision for the purchase of equipment for disaster response.¹⁹¹ As such, UASs are generally allowable as an equipment purchase under the grant; however, as with the HSGP, FEMA has temporarily halted the approval of equipment projects involving UASs. It is expected that FEMA will remove this stay on funding for UASs; however, this stay needs to be lifted sooner versus later to allow local EMAs to move forward with establishing a UAS program for those jurisdictions desiring to implement such a program.

3. Public Engagement and Education

Irrespective of its intent, vis-à-vis disaster management, law enforcement, or homeland security missions, privacy concerns represent a significant barrier against the implementation of a UAS program. In order to mitigate this barrier, the author recommends the establishment of a public engagement and education program to reinforce the benefits of using UASs for disaster response prior to the implementation of any such program. Failing to do otherwise risks a public outcry similar to the aforementioned events in Seattle, WA, which resulted in the termination of a UAS program due to a failure to win public support. The use of

¹⁹¹ U.S. Department of Homeland Security, *Fiscal Year 2015 Emergency Management Performance Grant Program Notice of Funding Opportunity* (Washington, DC: U.S. Department of Homeland Security, 2015).

UASs can and will result in saving lives, which is a critical point that needs to be conveyed to the general public to obtain support.

4. Identify a Local Lead Agency for the UAS Program

For UASs to gain acceptance for their potential humanitarian benefits, the local/county EMA should be the lead agency for a disaster response centric UAS program at the local level. Designating the local/county EMA as the lead agency for an emergency management specific UAS program can assist in mitigating or reducing privacy and government intrusion concerns associated with law enforcement and/or homeland security agency UAS deployments.

While it is recognized that having a UAS dedicated solely to disaster response missions may be redundant if the capability exists within, for instance, a local law enforcement agency, EMA-based UASs would provide capabilities focused on disaster mitigation, preparedness, response, and recovery. An additional benefit of having a UAS platform dedicated to disaster response would be the elimination of conflicting mission priorities with other agencies. Due to the dynamic nature of emergency management and law enforcement missions and the inherent life safety parameters that exist, a shared platform is not recommended. While some may posit this constitutes a duplication of effort and cost, it is a necessary redundancy to ensure the performance of missions when needed without mission prioritization conflicts.

The secondary benefit of having an emergency management specific UAS is due to the differences in mission types and the potential retention policy variances between a UAS focused on disaster response and one focused on law enforcement and/or homeland security missions (e.g., surveillance operations, special operations support). While this thesis advances a recommendation for an emergency management specific UAS, there should be no preclusion of using an emergency management UAS for a law enforcement and/or homeland security focused mission or vice versa should an emergency situation so warrant.

5. Consider Establishing a State-Level UAS Center

As mentioned previously, the states of Indiana and Ohio have collaborated to form a joint UAS center, located in Springfield, OH, to offer “a mix of resources and a variety of test ranges to support research, development, testing and evaluation of [UAS] technologies.”¹⁹² A UAS center situated at the state level as a proponent and supporter of UAS operations would serve as a valuable resource positioned to assist private and public sector partners with the establishment of a program.

In that UASs are considered aircraft by the FAA, albeit unmanned aircraft, a UAS center may very well serve as a component under ESF-1 Transportation or the department of transportation at the state-level. While organizing a UAS center as an asset under ESF-1 or the department of transportation at the state-level is not a requirement, it would be consistent with the organization of the Ohio/Indiana UAS Center, which serves as a partnership model for a state-level UAS center. In addition to the Ohio/Indiana UAS Center, there are other UAS centers at New Mexico State University,¹⁹³ Texas A&M University-Corpus Christi,¹⁹⁴ and within the North Dakota Department of Commerce.¹⁹⁵ Regardless of whether a UAS center is organized at the state level or resides within academia, its establishment is recommended so that a formal advocacy and research center is available to assist agencies seeking to establish a UAS program.

¹⁹² Ohio Department of Transportation, “About the Ohio/Indiana Unmanned.”

¹⁹³ New Mexico State University, “21st Century Aerospace.”

¹⁹⁴ Federal Aviation Administration, “FAA Announces Texas UAS Test Site Now Operational,” news release, June 20, 2014, Federal Aviation Administration, https://www.faa.gov/news/press_releases/news_story.cfm?newsid=16454.

¹⁹⁵ Federal Aviation Administration, “FAA Announces First UAS Test Site Operational,” news release, Federal Aviation Administration, April 21, 2014, https://www.faa.gov/news/press_releases/news_story.cfm?newsId=16154

6. Implement an Emergency Waiver Process for Immediate Life Safety Disaster Response Missions

Due to the life safety issues involved with responding to disasters, it is necessary to streamline the approval of emergency UAS flight operations (e.g., searching for flash flood survivors). The current 24-hour timeframe for the issuance of an emergency COA is unacceptable and needlessly jeopardizes human lives. The question of whether an FAA liaison working with a state-level UAS center or the FAA UAS Integration Office has the authority to issue the authorization/approval is largely inconsequential, as long as the approval process is immediate. However, a process must be in place to grant an immediate authorization to the requesting agency during emergency situations. One option for granting an immediate authorization is a provision for a waiver to obtain an emergency COA, or equivalent, in those situations where there is an immediate life safety situation (e.g., search and rescue operations). In these types of situations, minutes, or even seconds may be the difference between life and death for victims of a disaster.

Bogging down UAS approvals in a bureaucratic administrative process is simply unacceptable. The reality is that, should the FAA fail to implement an emergency waiver provision for the operation of a UAS in a life/death situation, emergency responders will do what they have to do and deploy UASs without any approval. While the FAA would assuredly consider this a violation of its rules as they currently exist, the FAA would never win this battle in the court of public opinion. Therefore, it is recommended for the FAA do what is prudent, which is to implement an emergency waiver process that can be initiated upon the order of an incident commander or local/county/state EMA director or, as previously mentioned, assign an FAA liaison that can issue an immediate authorization.

7. Establish an FAA Liaison Office for Local and State Government

The final recommendation, and arguably one of the most challenging to implement, will be the establishment of a liaison office within the FAA to work

directly with local and state government agencies seeking to establish a UAS program. While some may view this creation as an additional level of bureaucracy, an FAA liaison office, hereafter referred to as the liaison office, would serve a critical role in streamlining the UAS approval process for local and state government agencies. With a sole focus on local and state government programs, the liaison office would be able to expeditiously approve authorization requests as it would not be distracted with the management and approval of UAS operations for private sector organizations. This is an important point as heavy lobbying efforts by special interest groups appear to be garnering the majority of the FAA's attention, resulting in a hindrance to the implementation of government rules and regulations.

The establishment of a liaison office would not be without challenges and will need support from a diverse group of supporters. Therefore, a strategy must be developed and implemented if the recommendation to establish a liaison office is to be advanced. The selectorate theory, which includes the nominal selectorate, real selectorate, and the winning coalition,¹⁹⁶ will identify the key stakeholders involved in this initiative. This identification of stakeholders is necessary so the principals involved in establishing the liaison office recognize the patrons necessary to establish the program.

The nominal selectorate, or interchangeables,¹⁹⁷ represented in this strategy include the citizens that will benefit from the use of UASs in disaster response. This thesis has noted numerous instances where lives were saved as the result of a UAS deployment during disasters. There have also been multiple references to other UAS missions that have provided for public safety, including the aforementioned monitoring of radiation at the Fukushima Daiichi Nuclear Power Plant in the aftermath of the 2011 earthquake and tsunami in Japan.¹⁹⁸

¹⁹⁶ Bruce Bueno de Mesquita and Alastair Smith, *The Dictator's Handbook: Why Bad Behavior Is Almost Always Good Politics* (New York: PublicAffairs, 2011), Kindle ed., 4.

¹⁹⁷ Ibid.

¹⁹⁸ Everstine, "Drones Play Role in Disaster Response."

The nominal selectorate is a key stakeholder in the implementation of a UAS program for disaster response. Therefore, providing for public safety and security should be a top priority for the liaison office.

The real selectorate, or influentials,¹⁹⁹ represent those that “make it happen.” When introducing a concept such as the establishment of a liaison office within the FAA, its establishment must have support or the program will never gain the necessary momentum for implementation. While this support should begin as a grassroots effort at the local level, it takes the buy-in of those with influence over a particular area of government for this to come to fruition. In the case of establishing a liaison office, it will take the support of representatives in Congress, the secretary of the U.S. Department of Transportation and the administrator of the FAA to implement an initiative such as a liaison office.

The first challenge of establishing a liaison office will be convincing the influentials of the issues at hand and offering a feasible way to implement a program fostering the development of governmental UAS programs. Due to the variances in mission type and intent, it is important to separate the government use of UASs from the private sector use. Government-based UAS programs are focused on public safety and providing assistance during emergency situations and disasters, whereas private sector interests are primarily profit-driven with an emphasis on providing expedited customer service or enhanced services, all of which are implemented with the intent of obtaining a larger market share of a given service (e.g., delivery, geo-mapping, videography).

The winning coalition, or the essentials,²⁰⁰ includes organizations such as the Aircraft Owners and Pilots Association (AOPA) and its diverse membership. The AOPA is recognized as the largest, most influential general aviation association in the world.²⁰¹ As such, it represents the leading potential advocacy

¹⁹⁹ de Mesquita and Smith, *The Dictator's Handbook*, 4.

²⁰⁰ Ibid., 5.

²⁰¹ Aircraft Owners and Pilots Association, “About AOPA,” Aircraft Owners and Pilots Association, accessed December 7, 2015, <http://www.aopa.org/About-AOPA>.

group for the implementation of practical UAS rules and regulations. While its constituency is primarily private pilots and aircraft owners, the establishment of sensible UAS regulations would benefit both the public and private sector implementation of UAS programs.

Once created, the liaison office would serve as part of the winning coalition as their support translates to a victory for those local and state agencies seeking to establish a UAS program, yet are unsure of how to proceed with program implementation. The liaison office would assist the winning coalition by offering sample UAS policy guidelines, providing guidance and assistance concerning the completion of the documentation necessary to request an approval for a local and/or state UAS program, establishing and providing guidance on training and certification requirements, and offering technical assistance to assist in the implementation of the program. Additionally, local and state governments, as well as private sector organizations, are also part of the winning coalition. They offer their support to organizations such as the AOPA and UAS centers, which serve as advocates for the advancement of sensible rules and regulations governing the safe operation of UASs in the NAS.

Due to the numerous delays that have occurred with the issuance of UAS rules and regulations by the FAA, the expectations of the liaison office would be significant and, as such, the office must be empowered with the authority to implement the program. This includes the authority to streamline the approval and authorization process for local and state UAS programs so the programmatic requirements are not so stringent they stymie the development and implementation of governmental UAS programs. The liaison office would also need to implement the “validated learning principle” to ensure they are meeting the customers’ needs.²⁰² This validation can occur via regular feedback sessions and surveys with the office’s constituency. These sessions should be personal in nature with face-to-face meetings versus simply sending an online survey. For a

²⁰² Eric Ries, *The Lean Startup* (New York: Crown Business, 2011), Kindle ed., 8.

startup organization such as a liaison office to be successful, it must develop a business relationship with its customers and then nurture those relationships by balancing the needs of its constituency against practical rules and regulations.

The change proposed by this recommendation would benefit local and state agencies seeking to establish a UAS program by streamlining the application process for these agencies and offering technical support to assist in program implementation. It is critical for government agencies to have the option of developing UAS programs to enhance their statutory responsibilities to provide for the public safety of the general public. By opening the NAS to UASs in a practical and controlled manner, agencies such as EMAs, can respond more rapidly and efficiently to disasters for missions such as locating survivors of disasters (e.g., flash floods, tornadoes, landslides), environmental sampling, critical infrastructure inspections, determining building/structural integrity, conducting damage assessments, and compiling SA when determining a COP.

C. FUTURE RESEARCH

The topic of autonomous UASs presents a variety of issues that could warrant its own thesis focusing on the legalities, ethics, and perceptions associated with its implementation. As noted by the DOD's *Unmanned Systems Integration Roadmap FY2011–2036*, “[a]dvances in autonomy will further increase operational capability, manpower efficiencies, and cost savings.”²⁰³ Expanding the use of UASs to include provisions for autonomous operations will require an additional evolution in technology as well as increased acceptance by the general public of a platform operated with limited, and eventually minimal, human involvement. There are significant risks posed by the use of automated systems, regardless of platform (e.g., automobiles, UASs), which warrants extensive research and review prior to implementation. As the integration of

²⁰³ U.S. Department of Defense, *Unmanned Systems Integrated Roadmap FY2011–2036*, Report (Washington, DC: Government Printing Office, 2011), 46.

artificial intelligence into unmanned operations continues to advance, future research should include an examination of autonomous UAS operations.

The integration of fully autonomous UASs will not occur overnight and encompasses a four-level process as outlined in the *Unmanned Systems Integrated Roadmap FY2011–2036*. The first level of autonomy is essentially what exists today with UASs controlled solely by a human.²⁰⁴ This level of human control is asserted over all elements of a UAS mission, including take-off, performance of mission taskings (e.g., video, photographs, environmental sampling), re-assignment to a different area of responsibility (AOR), and returning to home base (i.e., landing).

The second level of autonomy involves the delegation of human control to the UAS. At this level, the UAS “performs many functions independently of human control when delegated to do so...This level... must be activated or deactivated by human input.”²⁰⁵ At this level of autonomy, functions such as travel to the AOR and activation of the payload (e.g., video, environmental sampling sensors) would be delegated to the UAS by the human operator.

The third level of autonomy “involves human supervised systems.”²⁰⁶ This level of autonomy results in a UAS performing a mission once given direction and guidance by a human operator. Autonomy at the third level results in more UAS control of a mission by allowing the platform to make adjustments to the mission assignment based on data that is received during the deployment. However, any adjustment to the assigned mission would have to be within the parameters of the current mission assignment (i.e., the UAS could not deviate from the AOR).²⁰⁷ The independence afforded the UAS at this level is significant and is only superseded by a UAS operating with complete autonomy.

²⁰⁴ Ibid.

²⁰⁵ U.S. Department of Defense, *Unmanned Systems Integrated Roadmap*; Annie Jacobsen, *The Pentagon’s Brain: An Uncensored History of DARPA, America’s Top Secret Military Research Agency* (New York: Little, Brown, and Company, 2015), 418.

²⁰⁶ Ibid.

²⁰⁷ Ibid.

The fourth and final level of autonomy is when the UAS becomes fully independent.²⁰⁸ At this level, based on the general direction provided by a human operator, the UAS performs tasks “without human interaction.”²⁰⁹ As noted by the DOD, “A human could still enter the loop in an emergency or change the goals, although in practice there may be significant time delays before human intervention occurs.”²¹⁰ This fourth level of autonomy is similar to the technology that is in the developmental phase for the U.S. Navy’s long range anti-ship missile, which can make adjustments en route to a target based on its radar sensing and evading technology.²¹¹ The future use of autonomous technology will assuredly manifest itself in many platforms (e.g., cars, military ground forces, planes, UASs, weapons systems) and will require oversight to ensure this technology does not morph into a “Hollywoodesque” scenario where humans lack control of the systems.

With the rapid expansion and prevalence of UASs in essentially all elements of society (e.g., military, hobbyists, private sector, first responder and emergency management agencies), it is critical to ensure practical and concrete regulations, policies, and procedures are in place to serve as a foundation to accommodate future advances in autonomous technology. While the FAA has experienced significant issues and complaints concerning the painstakingly slow development of rules and regulations regarding the use of UASs in the NAS, it must exercise extreme prudence when considering the use of autonomous UASs in the NAS.

²⁰⁸ Ibid.

²⁰⁹ Ibid.

²¹⁰ U.S. Department of Defense, *Unmanned Systems Integrated Roadmap*.

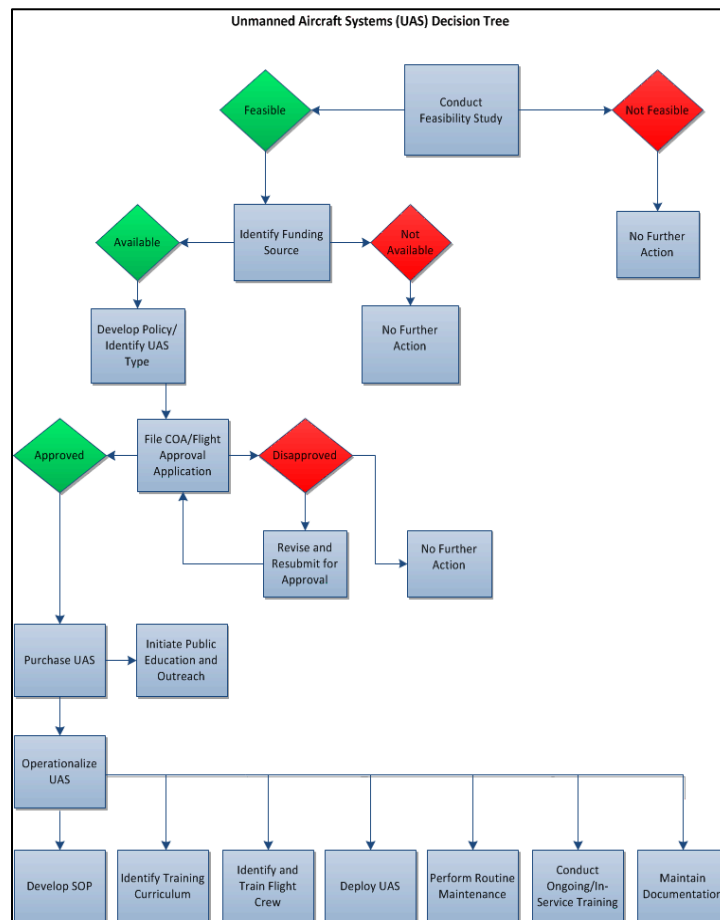
²¹¹ Tyler Rogoway, “The Navy’s Smart New Stealth Anti-Ship Missile Can Plan Its Own Attack,” *Foxtrot Alpha*, December 4, 2014, <http://foxtrotalpha.jalopnik.com/the-navys-smart-new-stealth-anti-ship-missile-can-plan-1666079462>.

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APPENDIX A. DECISION GUIDE

The decision as to whether or not to implement a UAS program requires an in-depth review and a comprehensive decision-making process. The intent of this decision guide is to foster that review and provide policy makers and practitioners with factors for consideration when assessing the need for an agency or jurisdictional UAS program. Listed in Figure 9, as well as in a larger format in Appendix B, is a decision tree that can be followed and a supporting narrative explaining each critical decision point and subsequent program area that should be considered, when assessing the need for a UAS program.

Figure 9. Decision Tree



A. CONDUCT FEASIBILITY STUDY

Not all feasibility studies are alike as there are a multitude of variables (e.g., equipment, organizational structure, new product designs) concerning its structure. The value in conducting a feasibility study should not be underestimated. However, the first step in conducting a feasibility study should be defining or describing the program.

B. PROGRAM DESCRIPTION

The UAS program description should note the type of missions the platform is intended to perform (e.g., search and rescue, environmental sampling, situational awareness, damage assessment) and if these missions are currently being performed via another platform, such as conventional rotary and fixed-wing aircraft. Additionally, an operational plan should be included in the description (e.g., criteria for deployment) and the proposed timeline from concept to implementation.

C. NEEDS ASSESSMENT

A critical component of any feasibility study is the formulation and conduct of a needs assessment. When evaluating the need to procure technology such as a UAS, it is important to conduct a needs assessment to ensure there is a bonafide need and that the procurement is not arbitrary. While the questions asked via a needs assessment may vary based on the subject, this thesis advances the following 12-step needs assessment process for determining the feasibility of implementing a UAS program:

1. Review of hazards and vulnerabilities affecting the jurisdiction
2. Disaster response missions currently performed and/or anticipated
 - a. How those missions are performed (e.g., ground-based, rotary or fixed-winged aircraft, satellite)
3. What gaps exist in the information gathered by conventional platforms?

4. Disaster response missions where the use of UAS will support and/or augment existing capabilities
5. What type of UAS (e.g., commercial off the shelf, military specification) is being considered?
6. What are the staffing, training, and support requirements of establishing a UAS program?
7. What are the anticipated costs to procure, implement, and sustain a UAS program?
8. How will the program be funded?
9. What will be the organizational structure for the UAS program (e.g., emergency management, public safety, department of transportation)?
10. What are the barriers concerning the implementation of a UAS program and what is the mitigation strategy?
11. Conclusions and recommendations
12. Next steps

D. IDENTIFICATION OF A FUNDING SOURCE

Should the needs assessment indicate the need for a UAS program and approval to move forward is granted by the agency's policy makers, the next step in the implementation process is to identify a funding source to support the program. As noted in the body of this thesis, while there are challenges concerning provisions of grant programs such as FEMA's HSGP, SHSP, UASI, or EMPG, there are multiple funding options that may be available for the implementation of a UAS program. Additional options for procuring a UAS may include, but are not limited to, volunteer services, leasing, departmental or jurisdictional funds/budgeting, community and/or private monetary donations, and the donation of a UAS by a manufacturer. One important provision for consideration when identifying a funding source(s) is the ethical implications of an individual or corporation donating a UAS to a governmental agency. Agencies or jurisdictions that may be considering the acceptance of a donated UAS should contact their legal counsel or state ethics commission to ensure such acceptance does not constitute an ethics violation.

The identification of a funding source to procure or obtain a UAS represents only one area of a UAS program. In addition to the costs associated with procuring a UAS, funding must also be in place to provide for a variety of programmatic functions, including funding to hire and/or train flight crews to operate the UAS; procure sensory payload equipment (e.g., FLIR camera, environmental sampling sensors), provide for maintenance and replacement part costs (e.g., batteries, rotors), initial and ongoing training, funding PIC and visual observer certification/re-certification costs, obtain liability insurance (unless self-insured), and maintain pilot proficiency. Absent funding for the aforementioned areas, the long-term implementation of a UAS program is likely not sustainable.

E. DEVELOP POLICY/IDENTIFY UAS TYPE

Once support and funding are in place for the implementation of a UAS program, the agency or jurisdiction should proceed with the development of a policy governing the parameters of the program. As noted previously, there is no national policy standard for UASs. To bridge this gap, Chapter VI of this thesis identifies recommended topical areas for a UAS policy. Additionally, research on the topic of UAS policies noted the inclusion of a policy model in a thesis authored by NPS alumnus John Wallace.²¹² Furthermore, Eric Holdeman, who authors a blog post for *Emergency Management*, advances a UAS policy model developed by John A. Gordnier.²¹³ Regardless of the policy outline followed, the critical takeaway is the need to develop a comprehensive UAS program policy.

The application for authorization submitted to the FAA will need to identify the type of UAS by size (e.g., small UAS if less than 55 pounds) and model (i.e., manufacturer name of the UAS), the UAS program policy should specify the type and model of the UAS to be used. It is also important to identify the type and

²¹² Wallace, "Integrating Unmanned Aircraft Systems."

²¹³ Eric Holdeman, "Model Drone Policy for Public Safety Agencies," *Disaster Zone* (blog), entry posted March 9, 2015, <http://www.emergencymgmt.com/emergency-blogs/disaster-zone/amodeldronepolicy.html>.

model of the UAS that will be used as it will frame the type of training that is necessary prior to the deployment of the platform.

F. FILE COA/FLIGHT APPROVAL APPLICATION

As noted previously in this thesis, the submission of a COA request or flight approval application to the FAA is required prior to the implementation of a governmental UAS program. Although there is a provision in place for the issuance of emergency COAs within 24 hours, these approvals are only for short-term UAS deployments. The standard COA approval process for UASs typically results in a formal response within 60 days of the submission of the application. The COA process as of the date of this thesis involves an online submission. The link to the online COA application process is <https://goo.gl/QMcYz>. A sample COA application, which is accessible on the FAA.gov website, is available at <https://goo.gl/eJRifc>.

The FAA's UAS Integration Office is the single point of contact concerning questions for the public or private use of UASs in the U.S. NAS. The current contact information for the FAA's UAS Integration Office is available by following this URL: <https://www.faa.gov/uas/contacts/>. Assistance with filing a COA can be obtained by contacting the FAA's UAS Integration Office.

G. PURCHASE UAS

Agencies and jurisdictions seeking to implement a UAS program should await the approval of their COA or application to operate before procuring a UAS. Upon notification the COA or application to operate a UAS has been approved, the agency or jurisdiction can proceed with procuring a UAS(s).

As noted previously in this thesis, while the current stay on using EMPG, SHSP or UASI funds for UAS procurement and/or sustainment is unfortunate, other funding sources, as well as donations, have been used by agencies developing a program. For example, two UASs were donated to the Medina County, OH, Sheriff's Office by a local vendor who was interested in a law

enforcement perspective as it developed its product line.²¹⁴ By partnering with a private sector entity, the Medina County Sheriff's Office was able to implement a UAS program that may not have been feasible otherwise due to budgetary restraints. While it may not be practical for every agency, if funding is limited, the donation of a UAS may offer a pragmatic solution for obtaining a UAS. As noted previously, prior to accepting a donated UAS, the agency or jurisdiction should contact its legal department or state ethics commission to ensure such receipt is authorized under local or state law.

Recognizing the procurement of a UAS can pose a challenge for many small agencies, this thesis encourages departments to consider small UASs when developing a UAS program as a means to mitigate this barrier. Small UASs weighing less than 5 pounds (2.2 kg) are significantly less expensive and are more rapidly deployable than larger UASs, which is an area of consideration when developing a UAS program. However, small UASs present operational challenges as they are typically more susceptible to air currents, have a smaller payload capacity, and due to having a shorter battery life, offer a reduced operational capability in comparison to larger UASs.²¹⁵ As technology evolves, it is expected that manufacturers will implement mitigation strategies to address the aforementioned limitations. Therefore, agencies and jurisdictions should ensure they fully research the needs of their UAS program prior to procurement.

H. ESTABLISH PUBLIC ENGAGEMENT AND EDUCATION OUTREACH PROGRAM

Given the media coverage and public perception concerning the domestic use of UASs in the NAS of the United States, it would be prudent for the agencies implementing a UAS program to consider establishing a public engagement and education outreach program. When the public is not educated

²¹⁴ Grazier, and Genson, "Medina County Sheriff's Office Drones Cleared for Flight."

²¹⁵ Jeffrey D. Barton, "Fundamentals of Small Unmanned Aircraft Flight," *John Hopkins APL Technical Digest* 31, no. 2 (2012): 132, 138, http://www.jhuapl.edu/techdigest/TD/td3102/31_02-Barton.pdf.

in the benefits of a UAS program, the agency or jurisdiction is limited in its ability to control the narrative concerning the implementation of the program. Such an oversight can result in a significant undermining of the program and a loss of public support. Chapter V of this thesis notes an example of such a loss of public support concerning the Seattle PD's short-lived UAS program. In this particular case, the Seattle PD had purchased two UASs and the program was reportedly canceled after a public outcry by the general public and a lack of support from city council and the mayor's office.²¹⁶ Such a public reaction has the potential to not only undermine a UAS program but can also erode public confidence in government agencies. The implementation of a public engagement and education outreach program can assail the espousing of potential concerns, rumors, and misinformation that may otherwise fester unabated concerning the humanitarian benefits of a UAS program.

While not inclusive, potential components of a public engagement and education outreach program include the use of public meetings, press releases via traditional media and social media platforms, TED Talks,²¹⁷ and general public service announcements. A comprehensive public engagement and education outreach program using a variety of media platforms would assist agencies and jurisdictions in controlling the narrative concerning the humanitarian benefits offered by UASs.

I. OPERATIONALIZE UAS

Operationalizing a UAS program includes developing SOPs, identifying the training curriculum for the flight crew, identifying and training the flight crew, ongoing maintenance operations, sustaining ongoing/in-service training, and maintaining program documentation.

²¹⁶ Clarridge, "Seattle Grounds Police Drone Program."

²¹⁷ TED Talks represent a relatively new concept of using short video presentations to convey new or innovative content. The typical TED Talk is less than 18 minutes in duration. More information on TED Talks is available at <https://www.ted.com/>.

J. DEVELOP SOP

Just as there is no national policy model for UASs, there is also a lack of a national SOP model. While an SOP for UASs may contain many of the components listed in a UAS policy (e.g., flight crew description, pre-flight, flight, post-flight duties and responsibilities), it is incumbent upon each agency implementing a UAS program to develop an SOP based on criteria they develop internally. In addition, an SOP should include, but is not limited to, minimum flight crew staffing levels (i.e., the flight crew for each UAS flight must, at a minimum, have a PIC and visual observer); call out procedures; emergency procedures; mission abort procedures; reporting requirements for flight operations; flight checklists; notification procedures for reporting in-flight incidents, near-misses, or crashes; transportation and storage procedures; record retention guidelines; competency training requirements (e.g., at least three takeoffs and landings within a 90-day period); and system propulsion information (i.e., battery or gasoline powered).

Research for this thesis identified an open source SOP for the North Texas Drone User Group that can serve as a reference for agencies or jurisdictions considering the implementation of a UAS program. The North Texas Drone User Group SOP is available at: <http://goo.gl/t49mX9>.

Additionally, agencies should consider including information concerning the FAA's B4UFLY app in their SOPs. The B4UFLY app "is an easy-to-use smartphone app that helps unmanned aircraft operators determine whether there are any restrictions or requirements in effect at the location where they want to fly."²¹⁸ The app is downloadable from the App Store for iOS devices or from the Play Store for Android devices.²¹⁹ Although not a requirement, the app is a valuable tool that is available to UAS flight crews to assist with pre-flight planning.

²¹⁸ Federal Aviation Administration, "B4UFLY Smartphone App," Federal Aviation Administration, accessed January 10, 2016, <https://www.faa.gov/uas/b4ufly/>.

²¹⁹ Ibid.

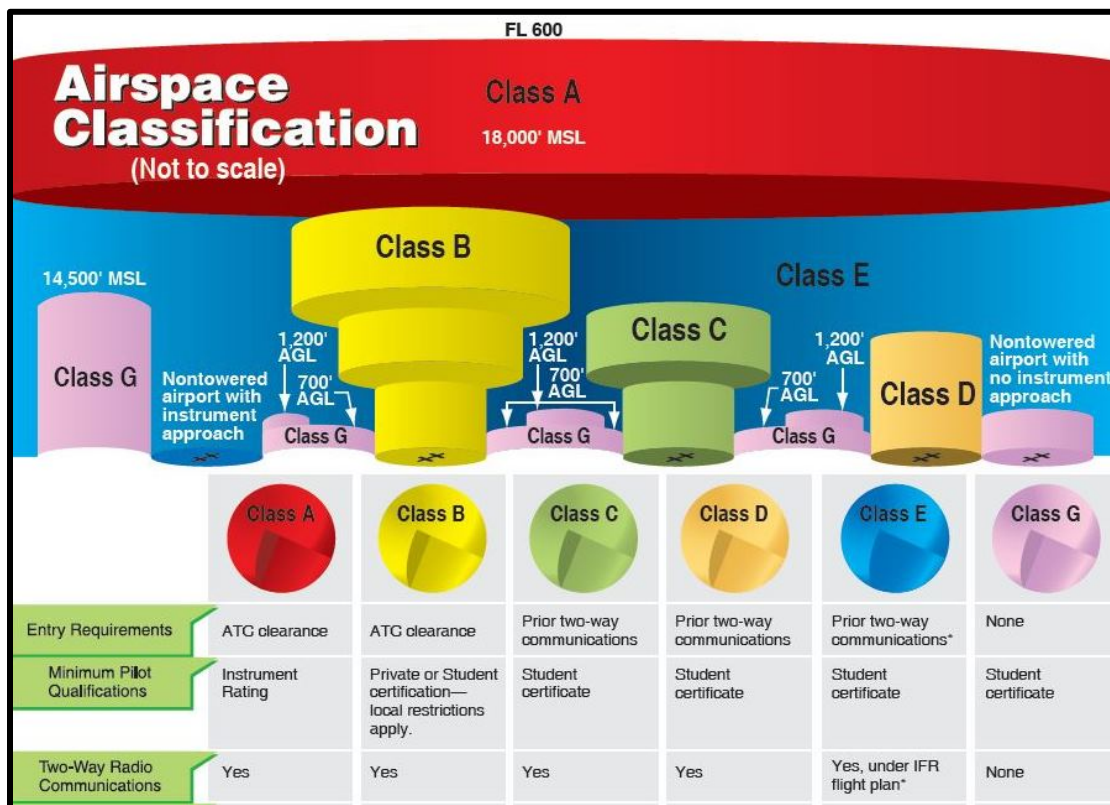
K. IDENTIFY TRAINING CURRICULUM

As noted in Chapter III of this thesis, the current certification requirements established by the FAA, which are subject to change, specify a pilot certificate (e.g., airline transport, commercial, private, recreational, or sport pilot certificate) is required for both the PIC and visual observer for UAS flight operations conducted in controlled airspace (e.g., Class A, B, C, D, E) and uncontrolled airspace (e.g., Class G).²²⁰ Minimum pilot qualifications by airspace classification are listed in Figure 10. While a pilot certificate is currently required for controlled and uncontrolled airspace, a proposed FAA UAS rule, *Operation and Certification of Small Unmanned Aircraft Systems*, would authorize the operation of a UAS in uncontrolled airspace without the requirement to obtain a pilot certificate as long as the PIC and visual observer have successfully completed the FAA Knowledge Test.²²¹ Additionally, until such time formal UAS flight training is recommended or required by the FAA, PICs and visual observers should follow the training recommendations outlined by the UAS manufacturer.

²²⁰ Federal Aviation Administration, "Airworthiness Certification," Federal Aviation Administration, "Section 333 Frequently Asked Questions."

²²¹ Federal Aviation Administration, "Operation and Certification."

Figure 10. Airspace Classification



Source: Federal Aviation Administration, *Instrument Flying Handbook*, 1–3.

L. IDENTIFY AND TRAIN FLIGHT CREW

Once the training curriculum has been determined and proceduralized, the UAS flight crew should be identified and trained in accordance with (IAW) the training curriculum. If the PIC and visual observer maintain a current FAA pilot certification, they should only need to complete additional flight certification requirements as deemed necessary by the FAA or the agency's UAS program. Regardless of whether the PIC and/or visual observer maintain a current FAA pilot certification, all flight crew members should complete the training requirements as outlined by the UAS manufacturer. Should the FAA implement a standard UAS training curriculum, the flight crew will need to successfully complete that training as well.

M. PERFORM ROUTINE MAINTENANCE

A critical component to any UAS program is the performance of routine maintenance and service of the platform. As noted in Chapter VI of this thesis, unless the agency fielding the UASs has maintenance staff with UAS maintenance experience or maintenance contracts in place, it is recommended that any maintenance exceeding preventative and basic upkeep (e.g., cleaning, tightening screws, attaching payload packages) be performed by the UAS manufacturer, especially concerning the maintenance of any electrical components. Additionally, maintenance logs are a requirement for all maintenance and repairs performed on a UAS. Furthermore, the agency program administrator should maintain routine contact with the FAA's UAS Integration Office to ensure compliance with any maintenance requirements or recommendations established by the FAA.

N. CONDUCT ONGOING /IN-SERVICE TRAINING

While initial flight crew training is critical for the implementation of a UAS program, ongoing and in-service training is equally important and an integral requirement that should be formally instituted. The training should be consistent with the recommendations outlined by the UAS manufacturer and/or the FAA. At a minimum, the PIC and visual observer should complete three takeoffs and landings in a 90-day period. It is expected that training recommendations and requirements will evolve with the issuance of additional FAA rules and regulations. Therefore, the agency program administrator should maintain routine contact with the FAA's UAS Integration Office to ensure compliance with any ongoing/in-service training requirements or recommendations established by the FAA.

O. MAINTAIN DOCUMENTATION

As with any flight operation, comprehensive and accurate documentation must be maintained for all components of the UAS program. The information captured for documentation purposes must be comprehensive, accurate, and

archived IAW the retention policy of the agency or jurisdiction. The documentation will need to be submitted to the FAA on a regular basis (e.g., monthly or quarterly) IAW the provisions of the COA or its equivalent authorization.

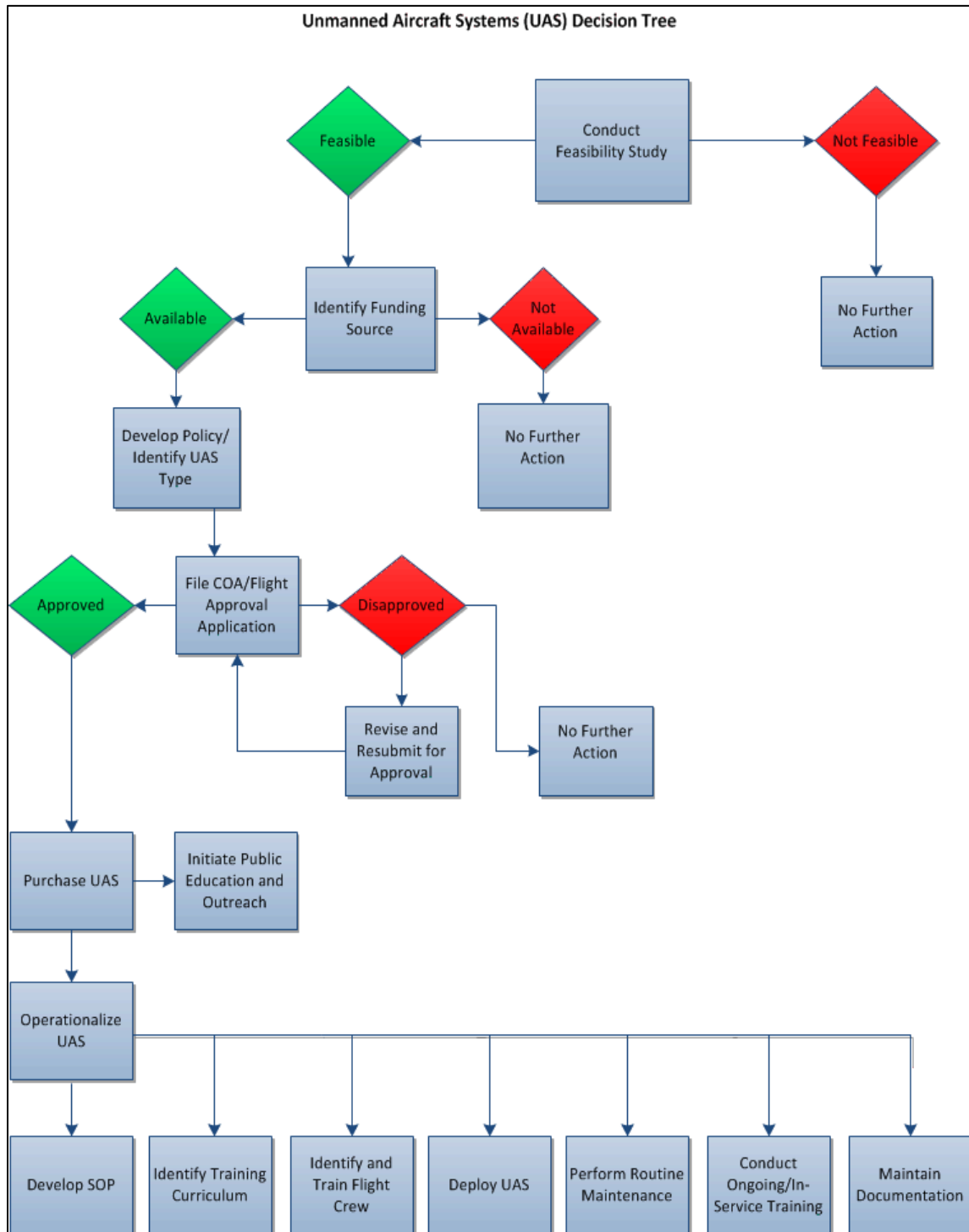
Additionally, the UAS program should compile an annual report of UAS operations and ensure it is accessible for public review. As noted previously, the requirement to publish an annual report should be contained within the agency or jurisdiction's UAS policy. At a minimum, the report should address the number of training and mission flights conducted, the number of flights that resulted in obtaining and storing information, the disposition of that information, training completed by the flight crew(s), and the approximate cost to operate the program.

P. SUMMARY

This intent of this decision guide is to provide a resource to assist policy makers and practitioners with the implementation of a UAS program. While information in this guide is current as of the date of this thesis, policy makers and practitioners should contact the FAA's UAS Integration Office to ensure compliance with current rules and regulations governing the operation of UASs in NAS of the United States.

Whether this document is considered in part or in its entirety, the key takeaway is the need to assess the need for a UAS program prior to implementation and to follow a process to ensure the establishment of a comprehensive, sustainable UAS program. As with any program, the agency or jurisdiction's legal staff should be a key member of the UAS implementation team to ensure UAS policies, procedures, applications, training, and documentation requirements are outlined and consistent with existing procedures and processes.

APPENDIX B. UNMANNED AIRCRAFT SYSTEMS DECISION TREE



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