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The Unmanned Aerial Systems (UASs) Industry and the Business Impacts of the Evolution of the Federal Regulatory Environment

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The Unmanned Aerial Systems (UASs) Industry and the Business Impacts of the Evolution of the Federal Regulatory Environment

by

Darren W. Spencer

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Business Administration
Muma College of Business
University of South Florida

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Keywords: Unmanned Vehicles, Aerial Photography, Drones, FAA, Disruptive Technology

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DEDICATION

This dissertation is dedicated to those who have supported me throughout my journey. A special thank you Dr. Douglas Marshall, Dr. Grandon Gill, Dr. Robert Tiller, Abbey, Henry, Athena, and above all, my wife Nicole Flores who sacrificed so much over the last 16 years of marriage to allow me to pursue my educational dreams.
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CHAPTER ONE: INDUSTRY ANALYSIS: UNMANNED AERIAL SYSTEMS

Note to Reader

The following chapter was published by this author in the Muma Business Review, Volume 2, Number 9, on pages 83 thru 104 on November 1, 2018. It is reproduced with permission under Creative Commons Licensing.

Tagline

Unmanned Aerial Vehicles (UASs), best known as Drones, are of ever-increasing popularity, and have given birth to an entirely new industry that encompasses the design, manufacturing, distribution, training, operation, and reporting on developments related to UASs. In addition, UASs augment many pre-existing industries, providing more efficient and effective solutions to a range of industry challenges.

Keywords

Unmanned Aerial Vehicles, Aerial Photography, DJI, Drones, FAA, Disruptive Technology, Aviation, Law Enforcement, Emergency Response, Agriculture, Construction

Executive Summary

In January of 2013, DJI, a relatively new and unknown company from China introduced the first consumer-grade unmanned aerial system. It gave users the ability to capture stable aerial imagery with little to no experience, minimal setup time, and at an accessible price point. They called it a “small size Ready-to-Fly VTOL, integrated multi-rotor aircraft for aerial filming”, and it started the UAS revolution (DJI, 2013).
Prior to this, UASs were primarily a surveillance tool for the military with a history dating back to World War I. These systems were largely based on designs and inventions patented by Nikola Tesla in the late 1890s, combined with the invention of the heavier-than-air craft made popular by the Wright brothers at Kill Devil Hills, NC in 1903. Tesla’s U.S. patent application 613,809 in 1898 accurately foretold the impact that unmanned craft would have (Atherton, 2016). “Vessels or vehicles of any kind may be used, as life, dispatch, or pilot boats or the like, or for carrying letters, packages, provisions, instruments, objects, or materials of any description, for establishing communication with inaccessible regions and exploring the conditions existing in the same” (United States Patent No. 613,809, 1898).

It is these exact roles that UASs are now creating a new Unmanned Aircraft industry, and will continue expanding into. Altogether new companies focus on the design/manufacturing, training, operation, and reporting on developments related to UASs, impacting agriculture, law enforcement, emergency response, communication, construction, and aerial photography among others. By 2025, some analysts expect over 100,000 new jobs and an economic impact of $82 billion directly related to UASs (Chamata, 2017).

This paper provides an analysis of each of the four major areas listed regarding UASs, as well as an analysis on how UASs are impacting four preexisting industries; construction/infrastructure maintenance, law enforcement/emergency management, agriculture, and aerial photography.

**Industry Analysis**

Throughout the history of Aviation, it is the unmanned aircraft, not manned aircraft, that are first to achieve historical accomplishments. The first lighter than air flights occurred in 1783 in France with no one onboard. In 1896 the first powered heavier than air flight was a steam powered unmanned craft launched by Dr. Langley from a house boat in the United States, six years before the Wright Brothers
flew their historic manned flight in 1903. Unmanned aircraft achieve transonic speeds today, but humans have yet to do so with anything other than the now cancelled space shuttle program, where transonic flight occurred only upon reentry as they glided back to earth.

Since writing “A Survey of Issues Related to Integrating Unmanned Aerial Systems into the NAS” (National Airspace System) in 2008, this author has seen the use of Unmanned Aerial Systems, otherwise known as “Drones” by both commercial enterprises and the general public, grow significantly in popularity and utility (Spencer, 2008). With a history dating back to World War I, UASs were once just a military tool for surveillance, largely based on designs and inventions patented by Nikola Tesla in the late 1890s and the invention of the heavier-than-air craft made popular by the Wright brothers at Kill Devil Hills, NC in 1903. UASs now execute military strikes in foreign countries, inspect critical infrastructure, assist firefighters and search and rescue crews, and deliver products to your door.

Prior to UASs, Tesla’s U.S. patent application 613,809 in 1898 accurately foretold the impact that unmanned craft would have (Atherton, 2016). “Vessels or vehicles of any kind may be used, as life, dispatch, or pilot boats or the like, or for carrying letters, packages, provisions, instruments, objects, or materials of any description, for establishing communication with inaccessible regions and exploring the conditions existing in the same” (United States Patent No. 613,809, 1898).

The Federal Aviation Administration (FAA) requires that all unmanned systems are registered, and the number of registered systems is growing at a substantial pace. In January of 2016, 300,000 such systems were registered, and that grew to 670,000 by January of 2017, and surpassed 1,000,000 in January of 2018 (Kratsios, 2018). By the estimates of key leaders in the FAA, there are at least as many unregistered, non-cooperative systems and operators in the United States, bringing the total number of UASs beyond 2 million in January of 2018. For an industry that only began selling their product in mass in January of
2013, with the introduction of DJI’s first consumer-grade unmanned aerial system, this is explosive growth.

By giving users the ability to capture stable aerial imagery with little to no experience, minimal setup time, and at an accessible price point, DJI introduced what many are calling one of the most disruptive technologies this century. Acting Director of the FAA, Michael Huerta stated in January of 2017 that “We're ushering in a new age of American aviation: the unmanned aircraft era. And it's moving at a quicker pace than anything we've seen before” (Huerta, 2017). This disruptive technology is just beginning to find its place and continues to test its limits in an already established infrastructure designed around the evolution of manned aviation, grounded in decades of lessons learned and lives lost.

The Industry

The UAS industry is global, but the primary market for this analysis is the United States. This is necessitated by three reasons; the extreme variance in regulatory frameworks surrounding UASs in various countries introduce variables that accounting for becomes cumbersome and adds little to no value, the United States is known for having the most complex airspace system in the world, and transparency and access to market information is much greater in the United States than in many other countries.

This paper looks at the UAS Industry in the United States and breaks it into four components; design/manufacturing, training, operation, reporting on developments related to UASs. It also provides an analysis on how UASs are impacting four preexisting industries; construction/infrastructure maintenance, law enforcement/emergency management, agriculture, and aerial photography. A broad scope is selected to give the reader a greater understanding of the market and the driving forces behind it, since the industry is relatively new and general understanding of this industry is in its infantile stages.
DroneDeploy, one of the three leaders in commercial UAS mapping software, ranks the DJI “Phantom 4 Pro as the most popular mapping drone” followed by DJI’s “Mavic Pro at 27 percent” and DJI’s “Phantom 4 is the third most popular drone, used by 16 percent pilots” (Juang, 2018). Due to the number of these systems now being used for commercial purposes, the impact of small UASs on manned aviation, and their impact on the manned aviation industry they are the focus of this IA. Follow on Industry Analyses will dive deeper into each of the submarkets discussed here as they mature and industry leaders mature.

**Stakeholders**

As with many industries, UASs have design/manufacturing, training, operation, and news outlets that report on industry developments. With commercial and recreational UASs being relatively new to market, based on rapidly evolving technology, it is important to consider how each of these categories of stakeholders impacts the development of the UAS industry.

The designers and manufactures of UASs play an important role in shaping the industry, but there are also commercial and hobbyist users, regulators, reporters, and the non-participative but nonetheless impacted community. Not included in the design and manufacturing of UASs for this analysis are manufactures of cameras, imaging systems, propulsion, navigation, or other components, or anyone who designs and manufactures accessories, supporting software, and add-ons.

There are a wide variety of UAS users, from those that have simple recreational systems to other that operate sophisticated and specialized commercial UASs. Real estate photographers, home inspectors, construction companies, utilities, cell-phone providers, farmers, miners, fish and wildlife, and emergency response agencies are just a few of the operators.
In addition, Unmanned Aerial Systems operate in an environment and space that existing manned aircraft and guidelines are already established. UASs then infringe not only on the physical space, but also upon the stakeholders of manned aviation. In particular, passenger airlines, cargo carriers, for hire commercial carriers including corporate aviation, general aviation, the Federal Aviation Administration and their 14,050 air traffic controllers, and even model aircraft hobbyists are all significant stakeholders in the evolution of the UAS industry and must be considered here (FAA, 2017C).

Supporting all of these are the researchers, who test new unmanned technologies for fielding to solve the problems of today. Seven FAA sponsored locations across the United States, ran by partnerships with academic, governmental and commercial affiliations, are exploring new technologies to deconflict the existing manned aviation from the new unmanned craft, detect errant and malintentioned systems, and extend the loiter time and range of future UASs.

Method
This Industry Analysis is the first of a three-paper series to fulfill the requirements for the DBA degree at the University of South Florida. Accompanied with the second paper summarizing expert interviews and a third synthesis paper, this IA is the first step in exploring the Unmanned Aviation Industry and the key obstacle(s) that impede growth.

The UAS industry is rapidly changing, with technological breakthroughs and regulatory initiatives shattering underlying assumptions almost weekly. This industry analysis was undertaken to better understand the industry as it exists today. Both formal and informal interviews of industry experts were conducted, as well as searches in JSTOR, Google Scholar, and with the assistance of the University of South Florida’s librarians.
As an emerging industry, there is very little academic literature that looks at the industry as a whole, and since the number one supplier of UAS systems is from China where there are no requirements to publicly release sales data, the size of the market is left to estimates and the insights of experts. Out of necessity, the primary sources of information for this industry analysis are reports from UAS news reporting organizations, speeches by industry experts at conferences, expert interviews, and the websites and public affairs releases of major players in the UAS Industry. In the course of research, it was found that very few studies of the UAS industry exist, and those that are available, repeat the same forecasted numbers. Due to the volatility and uncertainty of this emerging industry, it is unlikely that the forecasts would be the same unless they were using the same source. This may indicate that there is a significant lack of independent research in this industry.

**Analysis**

According to Michael Kratsios, Deputy US Technology Officer, and Executive Assistant of President, UASs will contribute to 100,000 new jobs and provide nearly $80 Billion in economic impact in the United States over the next decade, but "errant use poses unique safety and technological challenges" (Kratsios, 2018). It is these two opposing potential results that pit the advocates for fully integrating UASs into the National Airspace System against those that warn for caution and separation. The profit potential of being the market leader in a new industry clashes with an already established manned system that is recovering from years of losses following September 11, 2002, and regulatory agencies whose mission is the safe and efficient utilization of airspace, particularly of existing manned aviation, clashes with users who want unrestricted and free access at any time and may not necessarily understand the regulatory environment of the complex airspace system they want to occupy. UAS sales are growing irrespective of this, with sales doubling annually from 2013 to 2017, reaching an estimated 2.4 million units sold in the US in 2017 (Scott, 2017) (Meola, The Rise of the Drone Industry, 2017).
Regulatory Environment

Unmanned systems attempt to operate in airspace designed and regulated based on decades of experience in manned aviation, dating back to the Air Commerce Act of 1926 (FAA, 2017a). The FAA in its current form, which emphasizes “Safety First, Last, and Always”, was realized in 1958 with the passing of the Federal Aviation Act (FAA, 2017a). The first unmanned system to get authorization to fly within the National Airspace System (NAS) was the Global Hawk in 2003, nearly 100 years after the Wright Brothers made their historic first flight (Wall, 2003).

Due to “growing demand for public use unmanned aircraft operations”, in February of 2007 they issued UAS Policy 05-01, and defined an unmanned aircraft as “a device that is used, or is intended to be used, for flight in the air with no onboard pilot. These devices may be as simple as a remotely controlled model aircraft used for recreational purposes or as complex as surveillance aircraft flying over hostile areas in warfare” (Sabatini, 2007). This policy was the first of many attempts to fold UASs into the regulatory structure of manned aviation and marks the true beginning of the FAA’s attempts at comprehensive regulatory action regarding UASs. It was only a first step, meant to start the process that they knew would take years to complete, but in 2007 there was no way to know how, when, or how quickly UASs would explode onto the marketplace. Large winged aircraft similar in shape and size to manned aircraft were the only systems available, were only operated by highly skilled professionals, and the UASs in development at labs and research centers around the world were only dreams that were generally not seen as something marketable in the near future. The urgency to create a comprehensive integration policy was not what it is today, and it worked well in 2007 with the regulatory processes the FAA must follow.

The process the FAA follows when regulating air traffic is dictated by Federal law to ensure that all impacted stakeholders have an opportunity to be heard, that the executive branch can ensure that any new regulation matches their policy goals. It is comprehensive and time intensive by nature, but the required
coordination and reviews are the result of lessons learned over decades of federal regulatory proceedings. An *Unmanned Aircraft System Regulation Review* published in 2009 comprehensively analyzed “the applicability of Title 14 Code of Federal Regulation (CFR) to unmanned aircraft systems (UAS) operating in the National Airspace System (NAS)” to determine what regulations apply, what did not apply, and what may apply for unmanned systems (L. Kirk, D. Marshall, B. Trapnell, and G. Frushour, 2009). Title 14, Chapter1 of the Federal Regulations applies to the Federal Aviation Administration, with 12 defined subchapters covering all areas of aviation from sea level to an altitude of 60,000 feet.

This report could have been the springboard to a comprehensive overhaul of regulations to prepare for UASs, but instead the FAA took a slower and more piecemeal approach. It was not until November of 2013 that they published the *Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap*, did a seemingly refocused effort on UAS integration begin. Although a lack of presence of UASs may be partly to blame, the five-year long battle to get a long-term reauthorization and funding bill passed may explain more (National Business Aviation Assoc., 2012). Without a clear direction it is difficult for an organization to accomplish new and complex tasks.
It was section 333 of the FAA Modernization and Reform Act of 2012 (FMRA) that commercial UAS operators were able to use to get access to airspace, until Part 107 was released in 2016 (112th Congress (2011-2012), 2012). Section 333 was a complex code designed to ensure safety while allowing professional UAS operators access to the airspace. The FAA’s goals was to respond to requests within 120 days, but regularly it took much longer for the petition under section 333 to be approved. In the four years ending in September of 2016, only 5,551 petitions were granted across the entire United States (FAA, 2018a).

Part 107 streamlined the requirements and made the requirements for access to the airspace easier to define, but still forebode commercial operations within 5 miles of metropolitan airports and below 400 feet above ground level. The waiver process for these restrictions is still complex, and as of March 2018, over 12,000 waiver requests were awaiting review at the FAA’s UAS Integration Office (FAA UAS Symposium, 2018). To make it even more complex, operators with Part 333 approved petitions can still operate under those rules, or under other parts of Title 14 as well.

A UAS can operate as an Experimental Aircraft, can fly if granted a Type Certificate, operate as a Public Aircraft, or even follow Part 101 guidance for hobbyists. In each of these cases the rules become even more complex, and are typically attempted only by large UAS systems operators. Ultimately, very few commercial UASs attempt to use rules other than Part 107. No one other than emergency responders and law enforcement officials fall under Public Aircraft guidelines, and Part 101 is designed for model aircraft operators. The process to get a Type Certificate is extremely complex and time consuming, and to qualify as an experimental aircraft is almost as labor intense. Only the most specialized and experienced organizations attempt these endeavors. It is for this reason that this IA focuses on Part 107 operations.
An item of note is that the entire UAS Integration Office consists of just 13 employees. With an office this small, it would be impossible to enforce Federal UAS Regulations across the country, nevertheless process waivers for those that are attempting to operate in the defined limits. As a result, many small UAS operators operate without following these regulations, and it is impossible at this time to know how many do this, or measure the impact to a reasonable level of accuracy on businesses operating legally.

Beyond anything, FAA regulations are designed to keep the passengers of commercial airlines safe. The regulations of aviation are built upon the mistakes and failures of those that came before, but all aviation regulations have the caveat that the pilot is the ultimate authority for the safe operation of his or her aircraft. As one example, Part 121 of FAA regulations state that “In an emergency situation that requires immediate decision and action the pilot in command may take any action that he considers necessary under the circumstances. In such a case he may deviate from prescribed operations procedures and methods, weather minimums, and this chapter, to the extent required in the interests of safety” (Federal Aviation Administration, 2018). It is with this culture of safety and pilot authority, developed over 100 years of flight that commercial aviation within the United States operates.

Design/Manufacturing
The design and manufacturing of UASs for civilian commercial purposes may have many starting points, not the least of which being 2010 when a French company called Parrot introduced their AR.Drone at the commercial Electronics Expo (Johnson, 2010). The true explosion of UASs onto the market began when DJI introduced their Phantom quadcopter in January of 2013, which was the first consumer-grade unmanned aerial system that could be easily paired with a high resolution camera. Although other systems can claim their roots to earlier dates, including the Predator form 1994 or the Boeing Insitu ScanEagle from 2002, DJIs Phantom made a highly complex and formerly expensive technology accessible to the
general public. As of 2017, “more than two-thirds (68%) of all drones weighing over 250 grams are purchased for professional purposes”, and DJI systems hold a “72% global market share for drone purchases across all price points”, making DJI systems the largest commercial UAS platform (Snow, New Research: 2017 Drone Market Sector Report, 2017). This is by definition, a disruptive innovation.

Unmanned Systems Technology, a “dedicated directory of component, service and platform suppliers within the unmanned systems industry”, categorizes UAS manufactures into five categories today. In these categories, there are six Aerial Target Manufacturers, 33 Fixed Wing UAV Manufacturers, four Hybrid VTOL UAV Manufacturers, six Unmanned LTA, Blimp & Aerostat Manufacturers, and 48 VTOL UAV & Multirotor Manufacturers (Unmanned Systems Technology, 2018). The most popular and well know DJI, Parrot, and 3DR systems all fall within the crowded VTOL category, but between them they owned a commanding market share in 2016, speculated by some experts as over 90 percent.

This dominance is a direct result of their popularity in December of 2013, when many fledgling UAS pilots with no flying background found themselves with a nearly ready-to-fly UAS under their Christmas tree. DJI, Parrot, and 3D Robotics (3DR), make up most of the UASs used not just for hobbyists, but for commercial purposes as well. Yuneec, Zero Zero Robotics, Intel, and Hubsan are also players in the market, but their power in the marketplace is limited to the role of follower in most commercial applications rather than innovator or leader. The leaderboard is changing in 2018, with market leader, DJI, shoring up their position with price cuts and new technologies that make it difficult for their competition to sustain business. Some of the more notable competitors are included in greater detail below.
DJI

DJI had “90 employees and $4.2 million in revenue in 2011” and “grew to 1,240 employees and $130 Million in revenue in 2013”, the year they introduced their Phantom UAS (Nicas & Murphy, 2014). With a price of around $700 per system when initially released, this equates to nearly 186,000 UASs sold in 2013. Estimates from the FAA now place operable UASs in the United States are just over 2 million, and DJI is known to control approximately 70 percent of all UAS market share. With these assumptions, DJI is by far the number one manufacturer of aircraft in the United States, beating out all rivals to include Boeing, Airbus, and Cessna combined. Cessna, one of the most popular aircraft manufactures ever prior to this, has produced only 43,000 Cessna 172s since 1956 (Dowling, 2017).

Since introducing the Phantom, updated versions with significant upgrades in navigation, stability, obstacle avoidance, and user functionality, as well as entirely new systems designed for smaller personal use as well as more advanced commercial users have rolled off the production lines. Lower end systems include the Phantom 1 thru 4 series, the Mavic and Spark for more personal use, and the Inspire 1 and 2 with the ability to mount professional grade cameras and video equipment for commercial, NEWS, and mid-level movie productions. Industrial systems now include the Spreading Wings 1000 meant for ultra-high resolution DSLR cameras, and the Matrice 600 Pro that runs on six batteries, has a payload capacity of 6 Kilograms, and can fly for nearly 40 minutes (DJI, 2018). These larger systems cost upwards of $10,000. Based on comments during an interview in June of 2018 with the head of Corporate Communications, several more industrial grade systems are to be introduced shortly, showing an increasing focus on commercial systems rather than recreational ones.

Parrot

Parrot introduced the first UAS available at a price point targeted for the general public in 2010, and in 2013 their sales matched DJI in volume. Since then, they have taken a far second place in the UAS
market. In January of 2017, they announced that “290 staff members will be laid off out of the company’s 840 employees” as a result of fierce competition from DJI (Grigonis, 2017). Although sales were “63 million dollars, with 11.6 million attributable to commercial drones”, the decision was made to focus on commercial UAS systems where margins are expected to be higher (Grigonis, 2017). Data related to this effort to switch their strategic focus is unavailable at this time, but the move is similar to the strategic shift that DJI is also making.

3DR

In 2013 while DJI and Parrot were reporting sales approaching 200,000 units, 3DR touted sales figures in the “tens of thousands” (Hoge, 2013). Although seemingly successful at first, led by a founder of Wired magazine, 3DR abandoned the production of UASs and focused only on software. This was one of the most high profile UAS manufactures squeezed out of the market by lower priced DJI systems. As of June 2018, 3DR is making their mapping software available for use with DJI platforms.

Intel

Intel has made themselves a player in the commercial UAS market by carving out a niche with swarm technology for entertainment. They were scheduled to perform at the opening ceremonies of the 2018 Winter Olympics, but failed to get airborne. Television viewers were none the wiser as the performance was pre-recorded and on screen, it appeared to be playing out in real-time. Intel is also responsible for a Time magazine cover, 958 UASs flew at dusk to outline in the sky what looked like the cover of the magazine (Fitzpatrick, 2018). Disney also partners with Intel for special occasion light shows of a similar nature (Kaplan, 2016). Although Intel does have a smaller commercial UAS branch that designs and builds UASs for true commercial use, they are still a small market player. By using the partnerships with established, well-known organizations and events, Intel is likely announcing their intention to increase competition in the commercial UAS sector, and may become a major player soon.
Others Including Large UASs

Others like Intel, Boeing, Northrop Grumman, and AeroVironment have successful commercial UASs that are much larger and serve highly specialized purposes. Ranging in size from a few ounces to 32,000 pounds, with the ability to fly at all altitudes occupied by commercial manned aircraft, these systems are primarily used by governmental agencies and the military. Although unmanned, they do not resemble in any way the copter derived designs used by DJI, and look more akin to traditional winged aircraft.

The ScanEagle now owned by Boeing, a company long known for commercial passenger and cargo aircraft, and is likely the most successful large UAS ever built. It was originally designed to track schools of Tuna in 2005, but the platform’s capabilities were found to be good for a variety of specialized commercial applications. Although larger systems like this are important and test technologies that will eventually transition to civilian applications, these are not the UASs that are shaking up manned aviation today. Many of these systems existed in the late 90s and early 2000s, but it was not until 2013 that the commercial UAS revolution began, specifically with DJI and Parrot.

**Training**

In just one year after the introduction of Part 107, the commercial UAS pilot certification standard, which became effective on August 29, 2016, just over 100,000 people earned their Part 107 rating (FAA, 2018c). These pilots received their training from one of five types of aviation training organizations, of which three were not in existence prior to 2009. While some traditional pilots have added the UAS rating to their certifications list, and were educated at one of the manned aviation training schools, technical schools, or through the military, new UAS training organizations have emerged in three types of organizations to provide inexperienced students with the knowledge needed to pass the FAA’s Part 107 exam. Universities and Colleges provide a variety of degree earning programs, while other businesses and
professional interest groups provide short-term hands-on technical education, or students take online/distance/CBT based training.

Universities/Colleges
As of July 2018, 21 accredited colleges and universities are known to offer programs in UASs, not all of which lead to a UAS specific degree. Nine others are core members of the FAA’s Alliance for System Safety of UAS through Research Excellence (ASSURE) Center of Excellence on Integrating UAS in the National Airspace System, and conduct significant research related to UASs, but do not have specific degrees or minors for UASs. Traditional manned aviation powerhouses like Embry Riddle Aeronautical University (ERAU), the University of North Dakota (UND), and Kansas State Polytechnic, were among the first to offer degrees in UASs by expanding their manned aviation schools. New Mexico State University runs the first FAA testing center for UASs, and the University of Alaska, Fairbanks, recently became one of 10 selected for the FAA’s Unmanned Aircraft Systems Integration Pilot Program that began in 2018.

These pipelines are responsible for less than one percent of current certified commercial UAS operators, with only 476 students enrolled as of the Fall 2018 semester in the two largest four-year programs at UND and ERAU combined. This does though provide an additional revenue stream for these universities with students who may be interested in aviation careers, but are not qualified or interested in manned aviation. In addition, the research generated benefits the industry as a whole and by advancing technology, testing procedures, and building awareness through partnerships with civil and military organizations that would not be practical for commercial UAS operators to pursue.
The table below lists the identified institutions, notes the degrees available, and provides a few significant accomplishments or affiliations each school has. Trade or technical colleges without traditional academic requirements are not included in this list.

<table>
<thead>
<tr>
<th>Academic Institution Name</th>
<th>Degree Offered</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of North Dakota (UND)</td>
<td>B.S. in Aeronautics with a Major in Unmanned Aircraft System Operations</td>
<td>Selected as one of six FAA testing sites in December 2013 (Pedraza, 2013) On North Plains UAS Authority Executive Board with North Dakota State University (NDSU) who focuses on the engineering and design aspects but does not have a UAS specific degree track 194 students in UAS programs, 1,425 students enrolled in traditional programs (Bjerke, 2018)</td>
</tr>
<tr>
<td>Embry Riddle Aeronautical University (ERAU)</td>
<td>B.S. in Unmanned Aircraft Systems Science; Master of Science in Unmanned Systems; Undergraduate Minor in Unmanned Aerial Systems</td>
<td>Operates campuses in Prescott AZ, Daytona Beach FL, online, and thru dual-enrollment programs with High Schools in Florida 282 students in UAS degrees, 2,951 in traditional programs (Embry)</td>
</tr>
<tr>
<td>Institution</td>
<td>Program/Location</td>
<td>Notes</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
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<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>University of Alaska, Fairbanks</td>
<td>N/A – embedded within Aerospace Engineering or Aviation Maintenance Undergraduate Programs</td>
<td>Selected as one of 10 organizations for the U.S. Department of Transportation's Unmanned Aircraft Systems Integration Pilot Program</td>
</tr>
<tr>
<td>Purdue University, Polytechnic Institute</td>
<td>B.S. in Unmanned Aerial Systems</td>
<td></td>
</tr>
<tr>
<td>Central Oregon Community College</td>
<td>AAS Degree in Unmanned Aerial Systems</td>
<td></td>
</tr>
<tr>
<td>Oklahoma State University</td>
<td>Option in MS and PhD in Mechanical and Aerospace Engineering</td>
<td>OSU’s Multispectral Lab is a test bed for advanced military technologies, including unmanned systems</td>
</tr>
<tr>
<td>Texas A&amp;M University, Corpus Christi</td>
<td>Embedded within Department of Engineering with no academic options specific to UAS</td>
<td>On the forefront of UAS research as one of six locations selected by the FAA for UAS testing, but growth from testing center to an academic focus on UASs has not occurred.</td>
</tr>
<tr>
<td>Troy University, Alabama</td>
<td>Minor in UASs coupled with the Bachelor of Applied Science in Resource Management and Technology under dept. of Chemistry and Physics;</td>
<td></td>
</tr>
<tr>
<td>University</td>
<td>Degree and Specialization</td>
<td>Collaboration and Industry Partnerships</td>
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</tr>
<tr>
<td>Indiana State University</td>
<td>A.S. in Unmanned Aerial Systems.</td>
<td>Industry partnerships include Beck’s Seeds (6th largest seed producer in United States), and houses the “Center for Unmanned Systems and Human Capital Development” to collaborate with collaboration with the departments of Criminology, Electronics and Computer Technology, and Earth and Environmental Sciences</td>
</tr>
<tr>
<td>Lewis University, Illinois</td>
<td>B.S. in Unmanned Aircraft Operations</td>
<td>Operations focused, with active partnerships at both O’Hare and Midway International airports for manned aviation program</td>
</tr>
<tr>
<td>Middle Tennessee State University</td>
<td>B.S. in Aerospace with a concentration in Unmanned Aircraft Systems Operations</td>
<td></td>
</tr>
<tr>
<td>University of Nevada, Reno</td>
<td>Minor in Unmanned Autonomous Systems for any Undergraduate Engineering Degree</td>
<td>Not aerial specific</td>
</tr>
<tr>
<td>Kent State University, Ohio</td>
<td>B.S. in Aeronautics with minor in UAS</td>
<td>Awarded a research and development agreement (CRADA)</td>
</tr>
<tr>
<td>Institution</td>
<td>Degree Programs</td>
<td>Additional Notes</td>
</tr>
<tr>
<td>-------------------------------------------------------------------</td>
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<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>University of Louisiana at Monroe</td>
<td>B.S in Aviation with concentration in Unmanned Aircraft Systems; Post-baccalaureate Certificate in UAS</td>
<td>Mainly focused on Agricultural applications, but training is similar to other fields</td>
</tr>
<tr>
<td>Community College of Beaver County, Pennsylvania</td>
<td>A.A.S. in Unmanned Aerial Vehicle</td>
<td></td>
</tr>
<tr>
<td>California Baptist University</td>
<td>B.S. in Aviation Unmanned Systems</td>
<td></td>
</tr>
<tr>
<td>LeTourneau University, Texas</td>
<td>B.S. in Remotely Piloted Aircraft Systems</td>
<td></td>
</tr>
<tr>
<td>Green River Community College, Washington</td>
<td>A.A.S. in Unmanned Aerial Systems; UAS Basic Operator Certificate</td>
<td></td>
</tr>
<tr>
<td>Liberty University, Pennsylvania</td>
<td>B.S. in Aeronautics: Unmanned Aerial Systems</td>
<td>Two tracks available – operator and mechanic</td>
</tr>
<tr>
<td>Sinclair Community College, Ohio</td>
<td>A.A.S. in Unmanned Aerial Systems</td>
<td></td>
</tr>
<tr>
<td>Northwestern Michigan College</td>
<td>B.S. in Engineering Tech with minor in UAS Operations</td>
<td>Started in Fall of 2010, now offers 4 courses in UASs</td>
</tr>
<tr>
<td>Mississippi State University, Drexel University, Montana</td>
<td></td>
<td>Core members of the FAA’s Alliance for System Safety of UAS</td>
</tr>
</tbody>
</table>
State University, New Mexico
State University, North Carolina
State University, Oregon State
University, University of Alabama-Huntsville, The Ohio State University, Wichita State
University

through Research Excellence (ASSURE) Center of Excellence on Integrating UAS in the National Airspace System. Significant UAS research but no specific academic degrees or programs focused on UASs.

This list is relatively short, but it is in some ways very similar to manned aviation educational institutions. For example, there are the 216 schools out of the 4,627 degree granting institutions in the United States who offer Aviation training, but there are only 37 Universities and Colleges who offer aviation training that is rigorous enough to meet the Restricted Air Transport Certification (R-ATP) requirements of the FAA for pilots (Aircraft Owners and Pilots Association, 2017) (Chepkemoi, 2017) (United States Government Accountability Office, 2014). These schools train professional pilots to a higher standard that qualifies them for commercial flight with fewer hours in the cockpit than their non-certified counterparts. An Air Transport Certification (ATP), which is required to fly commercially with passengers onboard, is typically only available after 1,500 hours of flight experience. An R-ATP certified program can get you flying commercially with either 1,250 or 1,000 hours depending on the level the training location is certified by the FAA. The “R” is dropped after you reach 1,500 hours of experience. There is no equivalent certification yet for UAS operators.

In addition to these 216 manned aviation schools, there are also hundreds of technical school locations who specialize purely in flight training for manned aviation with no coursework beyond the minimums that are prescribed by the FAA for pilot certification. In Florida alone, there are 169 such locations, but listing them or going into significant detail is beyond the scope of this paper (Aircraft Owners and Pilots Association, 2017) (Chepkemoi, 2017) (United States Government Accountability Office, 2014). These schools train professional pilots to a higher standard that qualifies them for commercial flight with fewer hours in the cockpit than their non-certified counterparts. An Air Transport Certification (ATP), which is required to fly commercially with passengers onboard, is typically only available after 1,500 hours of flight experience. An R-ATP certified program can get you flying commercially with either 1,250 or 1,000 hours depending on the level the training location is certified by the FAA. The “R” is dropped after you reach 1,500 hours of experience. There is no equivalent certification yet for UAS operators.
Association, 2018). These location’s primary goal is to get a student to 1,500 flight hours to obtain their ATP certification, and some do so in as little as two years. UAS training is similar as well in this area, with the counterpart to these manned aviation technical programs in shorter term technical programs.

Short-Term Technical

There are several short-term technical training options available to someone pursuing a commercial UAS operator’s certification (Part 107) or additional UAS specialty training. A simple search online yields a multitude of options ranging from intensive one-day test preparation courses, 2 and 3-day training programs, computer-based training, and mixtures of all three. The longer the course and the proximity of affiliation to a traditional university or college sometimes shows how extensive the training is but is not always the case. Some of these programs are offshoots of pre-existing manned aviation training schools, while others are entirely new enterprises. The following table lists just a few of the more notable programs and provides some notes about each, but enrollment numbers are not readily accessible for all.

<table>
<thead>
<tr>
<th>Name</th>
<th>Website</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>UAV Coach</td>
<td><a href="https://uavcoach.com/">https://uavcoach.com/</a></td>
<td>Founded in 2014, Over 10,000 trained commercial UAS pilots, offer a variety courses including Part 107 certification, a 90-minute training session with 35 minutes of hands-on flying</td>
</tr>
<tr>
<td>Institution</td>
<td>Website/Link</td>
<td>Details</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Unmanned Vehicle University</td>
<td><a href="http://www.uxvuniversity.com/uav-pilot-training-certificate/">http://www.uxvuniversity.com/uav-pilot-training-certificate/</a></td>
<td>3-phase training for $3,500, with ground school, UAS simulator, and hands-on training at 9 locations nationwide. Just over 2,000 trained, and expanding to 150 schools across 11 states (Creedy, 2018)</td>
</tr>
<tr>
<td>Dart Drones</td>
<td><a href="https://www.dartdrones.com">https://www.dartdrones.com</a></td>
<td>Featured on Shark Tank, provides in-person, online, and industry workshops for individuals and 11 different professional applications, as well as test prep. Prices from $20 to $1,650. 8,604 trained as of July 11, 2018 (Owre, 2018).</td>
</tr>
<tr>
<td>Unmanned Safety Institute</td>
<td><a href="https://www.unmannedsafetyinstitute.org/">https://www.unmannedsafetyinstitute.org/</a></td>
<td>With over 5,500 trained students, and over 160 certified instructors, they are the standard for Industry Certification and partner with schools like ERAU.</td>
</tr>
<tr>
<td>Company</td>
<td>Website</td>
<td>Description</td>
</tr>
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<td>------------------</td>
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</tr>
<tr>
<td>Vale Training Solutions</td>
<td><a href="https://www.valetrainingsolutions.com/">https://www.valetrainingsolutions.com/</a></td>
<td>Provides training for everything from car mechanics to UASs. Example of a company with a very small section of business dedicated to UAS test prep. Hundreds like this.</td>
</tr>
<tr>
<td>MAG Aero</td>
<td><a href="https://magaero.com/">https://magaero.com/</a></td>
<td>Example of an aerospace training and service company with a specialty in midsized to larger UASs. Tailored to for hire commercial and military applications, they added unmanned operations in 2013. Trainers have over 30,000 logged hours of UAS experience and is a partner of the Alliance for System Safety of UAS through Research Excellence (ASSURE).</td>
</tr>
</tbody>
</table>

In addition, some larger university and college programs offer short certification programs to get you ready for the Part 107 exam or provide additional training. ERAU’s Professional Program in Small
Unmanned Aircraft Systems (sUAS) is one such example. Topics such as navigation and flight planning, the makeup of the National Airspace System, flight performance, payload planning and handling characteristics, weather, and crew resource management for sUAS are covered. FlightSafety, a provider of pilot training for airlines and the military, also offers a series of elective courses that include line-of-sight and beyond visual-line-of-sight (BVLOS) flight training, commercial sUAS operations management, risk-analysis programs in sUAS, and a UAS inspection class. These classes are not geared toward obtaining a Part 107 certification, but appear to target advanced users who desire additional knowledge in these areas.

There are also one-time training sessions held by professional organizations who provide training both in Part 107 certification as well as continuing and developing education at conferences and industry exhibitions. AUVSI, the Association for Unmanned Vehicle Systems International, is the largest of these organizations and partners with the FAA several times a year. The annual UAS Symposium is one of the largest UAS events in the country, only overshadowed by Interdrone’s annual commercial UAS expo. Typically, the day prior to the main event, these organizations hold a one-day training that is designed to prepare an individual for the Part 107 exam.

It is important to note again, that no matter what the program or the organization providing these programs, none of them had this type of training available, or in many cases even existed prior to 2009.

Online/Distance/CBT Based Training/Books

Unlike the previous sections, these types of training organizations are simply in the business of passing on just enough information to pass the Part 107 test, at the lowest cost to the customer. Many online programs have pre-recorded lessons, some include access to instructors to answer questions, and other are simply a CD or book that you study at your own pace. Many promise that you will pass the exam or you get your money back, and typically cost anywhere between $14 and $200. There are far too many to list
here individually, but considering that over 100,000 individuals now have commercial UAS licenses, the top aviation universities graduate less than 1,000 unmanned specialists per year, and just under 26,000 trained with short-term technical, it is probable that the other 33,000 and counting receive their training via these methods.

**Operation**

Although the manufactures can bring the technology to market, it is the user who finds innovative uses for it and brings commercial viability to the product. The UAS operators are some of the most visible industry members, and have adapted this technology meant for recreational use and turned it into a revolutionary commercial asset in existing industries. Although real estate and professional photography were fairly obvious transition points, UASs now play a role in many more arenas that are not as evident. In most cases, the use of UASs is limited to optical and other sensory collection. In the future, UASs are expected to provide delivery services for the “last mile” of the logistics chain, as well as provide passenger transportation services. The industries discussed below are currently using UASs, and are assumed to operate in complete compliance with Federal Regulations. It is known that many small UAS operators ignore these requirements and have yet to see consequences.

**Aerial Photography**

The first balloon flight occurred in 1783 at Versailles, and Joseph Nicéphore Niépce invented photography in Paris around 1826, so it was only a matter of time that the two technologies would be used in unison (Research centre of the Palace of Versailles, n.d.) (Harry Ransom Center, n.d.). Aviation was long used for surveillance and intelligence as the ultimate high ground, so being able to capture imagery for detailed analysis beyond what a single person could remember on their own or deem
important was priceless. In 1858, the first known aerial photograph was taken, again in France, when both aerial platforms and cameras had evolved enough to be used for such a purpose (Professional Aerial Photographers Association, n.d.).

Aerial photography focuses on imagery in the visible spectrum of light, and the best aerial photography companies process the raw images and turn the images into either meaningful data for customers, or high-quality images for historical or decorative purposes. It is unknown as to how many manned aerial photography companies exist in the United States, but several companies in Florida travel from Texas to New York and parts between providing imagery for customers. This indicates that there are only a few select companies that are able to provide the quality of service required for most repeat customers. The same types of images can be captured using UASs as with manned platforms, but there are limitations.

Aerial photographers across the United States today use helicopters and small aircraft with professional still and video equipment to capture significantly detailed imagery. Manned aircraft are expensive, and include the cost of aircraft rental, pilot, and fuel. Fixed wing aircraft are cheaper than rotary wing craft, but even at $120 per hour plus a pilot and fuel, the direct cost of a single shoot can run in the hundreds of dollars. A basic 3 seat helicopter can cost $600 per hour alone. There are advantages though as compared to UASs.

A UAS averaged 27 minutes of flight time, while manned aircraft can stay aloft for upwards of six hours. Manned aircraft can fly hundreds of miles and survey distant locations, or even visit multiple sites in one trip, while a UAS must stay within five miles of the transmitter, and has to be transported from site to site if the distance is greater than that. Given current FAA regulations that require an operator to remain within visual sight of their aircraft, very few UASs can travel beyond half a mile before violating this rule.
Real estate photography is one of the areas where aerial photography has taken hold, but unless a real estate agent is a certified commercial UAS pilot, they cannot legally take photographs at a price point worth doing for most properties. Just because an agent lists a property, does not mean they will be the one selling it. Only with luxury priced properties, or commercial real estate does the cost of aerial photography make good business sense if you have to hire an outside professional.

Talking with the owner of one aerial photography company in Florida, the owner stated that having a UAS can serve a purpose, but in most cases they are unable for either technical or regulatory reasons to meet the needs of clients. In some ways, a UAS is more of a marketing tool, since customers come in specifically asking for “drone footage”, and being able to provide that helps to retain customers. It is impossible though to compete on price for a single job when a sole UAS operator with no overhead offers aerial imagery for $100. To date, this author has yet to see an operator at that price point remain a going concern for more than a few months.

Construction/Infrastructure Maintenance

Construction in the United States contributes to at least $660 billion in economic impact in the United States in the fourth quarter of 2017 alone (Federal Reserve Bank, 2018). The top 10 private construction projects for buildings slated for 2018 are valued at $26.2 billion, and the top 10 governmental projects for buildings are over $12 billion (ConstructConnect Project Research, 2017). Highway construction expenditures in 2017 were “over 87.7 billion U.S. dollars” (Statista, 2018). Managing these large, expensive projects involving thousands of workers, making sure that not just the quality but the size and location of the work is up to standards is vitally important. Additionally, the equipment, supplies, and employees must be kept secure and safe from burglary or mishaps, but managers cannot be everywhere at all times. This is why “construction drone usage has skyrocketed by 239 percent year over year”, with a large portion of this increase attributable to midrange DJI systems (Juang, 2018).
Infrastructure maintenance faces similar challenges, but includes the additional challenge faced when needing to inspect one of the tens of thousands of cellular towers, millions of miles of utility lines, or the remote and extremely difficult to get to oil and gas lines stretched across the country.

Aerial photography has long been the method of choice for its ability to provide high quality images to managers, but the cost of this imagery makes frequent checks cost prohibitive, and managers must identify critical phases of a project that will garner the greatest value at the right time. Depending on the size of the project, particularly with highway or utility projects, manned aviation was the only way to capture the imagery due to the distance needed to travel. UASs when properly calibrated and equipped are poised to change this.

UASs have the same imagery capabilities as manned aircraft, but face the same limitations mentioned in the aerial photography section above. One advantage is that sending a UAS to survey a site can limit the number of employees in dangerous locations, or managers can routinely send a UAS to capture the latest progress on a critical task or location. A PBS report in 2012 found that “nearly 100 tower climbers have been killed on the job” with half of them occurring on cell towers (Day, 2012). Rotary wing UASs can easily scale towers and capture multispectral imagery, and fixed wing UASs can travel long distances, with some systems now able to stay airborne for as long as 10 hours. These systems are again, highly specialized and limited to larger companies with larger pockets, but the technology exists and is starting to be used. Xcel Energy on April 18, 2018, received the first BVLOS waiver under Part 107, and stated that these “flights that will enhance grid reliability and safety for our employees” (Lillian, 2018). Although smaller UASs operators are unable to match the specific requirements of larger companies at this time with the typical UAS, it is possible today. As equipment costs decrease, the number of commercial operators offering services to these companies will significantly increase.
Law Enforcement/Emergency Management

Any aircraft operating for law enforcement or rescue purposes is considered a “Public Aircraft” and has specialized regulations regarding training and use. Public entities are allowed to create their own training programs and certify their operators without taking the standard 35 question Part 107 exam administered by the FAA, and airspace waivers are not required when the operation of a UAS is specifically for law enforcement or rescue purposes. There are many unsettled legal issues regarding privacy and probable cause, but these issues are beyond the limits of this paper.

Even without these issues settled, public agencies are buying and using UASs. In 2016 “at least 167 agencies” purchased UASs, bringing the total to “at least 347 local law enforcement, fire and emergency responder agencies” with UASs (Glaser, 2017). Of the UASs purchased, almost 80 percent were manufactured by DJI (Glaser, 2017). UASs can aid the Police, Fire and rescue teams in determining the safety of an environment before entering, ascertain the location of suspects, maintain situational awareness during events or even search for missing persons. Fire fighters can use infrared cameras to identify hotspots and monitor the locations and conditions of their teams or to find those that need assistance. The ability to attach both infrared and high definition cameras to highly portable and maneuverable systems provides police a perspective that helicopters and fixed wing aircraft were not able to provide before.

Police and search and rescue agencies are just learning how to use UASs and will find many more ways to employ the technology, but real world examples of UAS use already exist. On May 31, 2018, “four people were rescued by drones in three separate incidents on two continents on a single day”, with “the total number of people rescued from peril by drones around the world to at least 133” (Lisberg, 2018). The limitation is again a battery life ranging from 25 to 35 minutes, but this is sufficient for most purposes.
Agriculture

This author’s first introduction to commercial UASs was in the field of agriculture in 2006. Larger systems were used like the newer mid-sized systems of today to take imagery of crops in the near-infrared and infrared to spot diseases, pests, determine nutrient requirements, and analyze irrigation needs. Some in the industry envisioned a day when UASs would carry and distribute herbicides, pesticides, and fertilizers with the aid of GPS to limit applications to the absolute minimums needed to reduce cost and minimize environmental impacts of their use.

Today, all of this is possible, but with smaller platforms. These UASs are highly specialized, can cost upwards of $10,000, and represent only a small portion of UAS sales nationwide, but UAS use has still climbed “172 percent in agriculture” in 2017 (Juang, 2018). Some models can “can fly a square mile in 30 minutes”, and now can track herds, help find lost animals, providing a utility again only possible with manned aircraft (Morgan, 2014). About 63% of agricultural users operate the systems themselves, which is easier in agricultural environments (McNabb M., 2017). A typical farm is outside the 5 mile ring surrounding towered airports, placing them in airspace that allows them to fly their UASs up to 400 feet without restriction or special certification. Although the airspace outside of 5 miles from an airport is not as crowded, there are still risks. Near Charleston in February of 2018, a helicopter claimed it was almost struck by a DJI UAS (Henderson, 2018).

Other Applications

There are a number of other applications that UASs have, including fish and wildlife management, mining, and product delivery; the options are nearly endless and limited only by what people dream of. Amazon.com, Dominoes, UPS, DHL, and 7-11 all have had plans at one point to deliver goods “the last mile” of the logistical chain, but have not provided sufficient safety evidence to convince the FAA to allow their services to ramp up to full capacity.
The creative uses of UASs are not always in the best interest of society and may not be of the highest moral calling, but as with every new technology, there is always some negative to go with the positive. It is these people who can significantly and negatively impact industry growth.

**News Outlets**

There are a number of traditional aviation news outlets that report on UAS developments, with reporters now specializing in reporting on unmanned aviation. Also, many entirely new organizations report on industry developments, with the major organizations being Unmanned Systems Technology, AUVSI, UAS Magazine, Unmanned Aerial Online, sUAS News, DroneLife, and UAS Vision.

One of the largest of these new organizations, sUAS News founded in 2008, employs 9 people and continually updates readers on the latest developments in anything related to UASs, civil or military. They provide links to employment for unmanned operators, airspace maps, and categorize stories based on topics like many news agencies do. DroneLife, a mainly online service, was ranked number one by Alexa.com in 2015, and has “partnerships with over 250 commercial drone enterprises worldwide” (McNabb H., 2016). AUVSI is an organization that is now 40 years old, and has an extensive database on all things unmanned, including air, land, and underwater craft.

These agencies not only employ individuals with an interest in unmanned systems, but they provide operators, manufactures, distributors, educators, and researchers with daily updates on industry developments. Without these specialized UAS reporting organizations, this IA would not have been possible, for traditional news organizations would not provide the same detailed information at the same frequency or understanding of the industry environment.
Pre-Existing Aviation

Civil Aviation

According to the latest report from the FAA, “civil aviation accounted for 5.1 percent of U.S. gross domestic product (GDP), and generated $1.6 trillion and supported 10.6 million jobs with $446.8 billion in earnings” (FAA, 2017d). This includes all commercial carriers, both passenger and cargo, and is the preferred method of travel for most when traveling long distances or overseas. 965 million passengers and 39.9 billion pounds of cargo moved via civil carriers in 2017 (National Air Traffic Controllers Association, 2018). This was all accomplished in 2017 during the safest year ever for commercial aviation, with no fatalities due to accidents (Shepardson, 2018).

These results are not exceedingly surprising, considering the strong culture of safety within civil aviation. FAA regulations are designed to keep the passengers of commercial airlines safe. The regulations are built upon the mistakes and failures of those that came before, and the training of professional aviators reinforces this culture from day one until retirement. What does make this surprising is that operating within the same airspace as these aircraft, were 2,125 reported sightings of unauthorized UAS activity at altitudes above 400 feet or within the confines of the airspace surrounding the approach and departure of airports across the United States, which is forbidden by federal law (FAA, 2018b). Many of these reports were at altitudes in excess of 3,000 feet, with some as high as 8,000 feet. Considering the size of these systems, that all sightings are visual only as UASs currently do not have detect and avoid systems, and that commercial airlines fly between 150 and 250 knots at these altitudes, it is highly likely that thousands of other unauthorized UAS flights occurred and went unnoticed. New technologies being researched that detect the signals used to control UASs and their locations will soon shed light on the real severity of the problem.
The primary concern of civil carriers is that they do not want one of these unauthorized operations to be the mistake or failure that writes another regulation. Pilots and Air Traffic Controllers go through years of training before starting their careers, and have prescribed continuing training to stay current with regulations and familiar with emergency procedures. An untrained and unknowing UAS operator in controlled airspace has the potential to cause a serious if not fatal accident. In speaking with aviation safety expert Mr. Paul Sichko in Jun of 2018, although aircraft know the dangers of striking wildlife in flight, it is unknown what damage a composite structure powered by lithium batteries can do to a commercial airliner, particularly when it hits critical flight surfaces or is ingested into an engine (Sichko, 2018).

A secondary concern is that many of the airports in the United States are already extremely busy, with Atlanta International having 2,700 arrivals and departures daily (Hartsfield-Jackson Atlanta International Airport, 2018). One errant UAS can shut down operations at a single location, but the impact would ripple through the entire aviation system with delays, missed connections, and excess operating expenses. Midsized jet aircraft cost between $6,500 and $7,900 per hour on average to operate, so an additional 10 minutes of flight time for 56 aircraft during one short incursion (average arrival rate for Atlanta over 30 minutes), can cost the industry over $65,000 (Marsh, 2015).

General Aviation

General Aviation (GA) includes the aircraft, operators, mechanics, and support personnel and infrastructure that enables anyone not involved in passenger, cargo, or military aviation to operate. The latest report on GA from PricewaterhouseCoopers defines it as the manufacture and operation of any type of aircraft that has been issued an airworthiness certificate by the FAA, other than aircraft used for scheduled commercial air service or operated by the military”, and says that “general aviation, in total,
supported 1.1 million jobs and $219 billion in output” in 2013 (Contribution of General Aviation to the US Economy in 2013, 2015).

The GA community is very influential in the United States, and their influence is the main reason that the airspace is considered the most complex in the world. The various classes of airspace and the rules surrounding them are the result of decades of lobbying and compromises between civil and general aviation.

The pilots flying in GA are typically but not always less experienced, less current, operate less advanced and much smaller aircraft, fly at altitudes below 10,000 feet for most if not all of the flight, and often are outside of controlled airspace. GA aircraft flew over 24 million hours each year, with 164,200 fixed wing and 10,500 rotorcraft, as compared to 6,871 commercial aircraft, in operations nationwide (FAA, 2017C). All of these characteristics except for their lower operating speeds make GA much more vulnerable to UAS incursions.

The concern is again safety. With over 2 million UASs in the United States, all potentially operating in the same airspace as GA aircraft, it may unfortunately only be a matter of time before a fatal accident occurs. A strike on a control surface of a small GA aircraft, or even into the single engine that most of these aircraft use for thrust, could be catastrophic.

Model Aircraft

One of the more surprisingly influential stakeholders in the UAS industry is the model aircraft operator. Backed by the Academy of Model Aeronautics, they were influential in drafting some of the initial regulations for UASs in the 2013 to 2014 timeframe as UASs rose in popularity. Part 101 carved out model aircraft operators as separate entities that did not require the same regulatory oversight as other
UAS operators, and to this day, that standard continues. This group of avid model aircraft enthusiasts started in 1936, and has a national headquarters and museum that employs at least 61 people (Academy of Model Aeronautics, n.d.). Although total membership is unknown, 58,771 people are listed as followers on Facebook.

The impact on model aircraft owners is difficult to determine. Model aircraft operators had designated airfields and airspace they stayed within long before UASs were invented, and this author is unaware of any instance where a model aircraft operated by a member of the AMA that caused any issues for manned aviation. The most likely short-term impact on this community as the awareness of UASs grows, is that they become mistakenly grouped with uncertified and errant UAS operators, which could threaten their ability to operate as they have safely done for decades. The greatest long-term impact could be a loss of membership due to a demographic shift toward UASs rather than model aircraft. Part 101 strikes a favorable balance for their interests, and may explain their relative silence on regulatory issues related to UASs in the last 2 years.

Air Traffic Controllers

Responsibility to maintain separation of all aircraft flying under instrument conditions, or within the confines of major airports with an operating control tower, are just over 14,050 Air Traffic Controllers (ATC) (FAA, 2017C). They rely on flight plans, radio calls, standardized procedures, radar, and electronic location transmitting devices on aircraft to maintain safety within the prescribed limits. At the largest airports, ATCs manage 2 to 3 arrivals per minute using several runways, hundreds of taxiways, and parking locations scattered across hundreds of acres of real estate. Their customers range from student pilots to commercial carriers of both passengers and cargo, as well as military, private corporate aircraft, and law enforcement, flying fixed wing and rotary wing aircraft. There is a reason that Air Traffic Controllers are regularly named as one of the most stressful occupations in the world.
UASs flying in or near the airspace that ATCs are responsible for not only add to the complexity of the environment for controllers, but increase the risk to manned aviation. The technology that controllers use to detect manned aircraft, is largely ineffective with UASs. Radar systems are designed to detect large, metallic aircraft, rather than small composite multicopters, and location beacons that integrate with the government owned algorithms of TCAS (Traffic Collision and Avoidance System), are just beginning to get small enough to be onboard larger commercial systems. UASs do not typically file flight plans, few operators have radios to converse with controllers, and standardized flight procedures are not established for any but the most developed UAS operators.

This leaves controllers nearly defenseless. The low flying UASs occupy the same low altitudes that manned aviation must transition for takeoff and landing, which is also statistically the most vulnerable altitudes for fatal accidents, without the additional risk of UASs. Pilots rely on controllers for safe separation, yet in the case of UASs, it is now the pilots who are reporting UAS incursions for controllers to relay to others. This is a similar procedure to what aircrews do when spotting birds or other hazards inflight, but this hazard is entirely human made and, in most cases, avoidable. Following the FAA regulations and only operating in approved areas would eliminate all but the rarest of safety instances, when a UAS loses contact with the controller and wanders without control.

**Researchers**

Supporting all of these are the researchers, who test new unmanned technologies for fielding to solve the problems of today. Seven FAA sponsored locations across the United States, ran by partnerships with academic, governmental and commercial affiliations, are exploring new technologies to deconflict the existing manned aviation from the new unmanned craft, detect errant and malintentioned systems, and extend the loiter time and range of future UASs. These locations are run by the North Dakota Department of Commerce, the State of Nevada, New Mexico State University, the University of Alaska Fairbanks,
Texas A&M University Corpus Christi, Virginia Polytechnic Institute & State University, and Griffiss International Airport (NY) (FAA, 2017b). In total, “[t]wenty-three of the world's leading research institutions and a hundred leading industry, government partners” are involved in designing, conducting, and reporting on a variety of topics of interest.

Some of the areas of greatest interest to these testing sites includes Beyond Visual Line of Sight (BVLOS) and Detect and Avoid technologies.

In addition to the efforts by the FAA, NASA reached the milestone flight of a UAS in the NAS without a chase aircraft, which was the goal of a 5-year effort, on June 12 of 2018 (Northon, 2018). With a waiver from the FAA, they operated in all classes of airspace all the way up to 20,000 feet. In all known instances, the aircraft detected potential conflicting traffic and relayed that information to the pilot on the
ground, with “all test objectives successfully accomplished” (Northon, 2018). The system flown was a larger UAS with sophisticated radar and electronics onboard, which is not available for most small UASs.

Other testing locations exist throughout the county for specialized, industry specific purposes, but are not affiliated with the FAA, and their advancements are difficult to correlate to efforts to integrate UASs into the National Airspace System. Although some groundbreaking work is being done at these sites, they are beyond the scope of this IA.

**General Public**

The relationship between stakeholders can significantly influence the ability of a technology to evolve and succeed. Since “it is possible for minimum quality standards to stop welfare enhancing innovation”, a budding industry like UASs, that currently uses aviation regulations built to provide extremely high levels of safety in manned aircraft, could be vulnerable to stifled innovation and growth (Blind, S.Petersen, & A.F.Riillo, 2017). Improperly or incompletely designed and implemented regulations related to UASs could seriously undermine industry growth.

328 million people called the United States home in July of 2018 (U.S. Census Bureau, 2018). Nearly every one of them is impacted directly or indirectly by UASs, either as family member of the over 2.4 million who purchased a UAS in 2017, the approximate 6 million who have at some point in their lives owned a UAS, or the countless other who have seen, or benefited from the services provided by a UAS. National news coverage such as seen on 28 November 2017 on NBC’s Nightly News, increase awareness and indicate a significant uptick in concern regarding UASs (Holt, 2017). Like all things, not all of the 328 million are pleased with UASs, and there are issues that society must face in the near future as UASs take their place in society. As issues are settled, they are likely be codified in regulations and law.
In 2016, the FAA started an annual national UAS Symposium focusing on UAS regulation, with the most recent symposium occurring from 6 thru 8 March, 2018. This brought over 950 interested representatives from government, industry, and academia together to balance the needs of all stakeholders. The FAA’s Acting Director, Acting Deputy Director, Acting Director of Flight Standards, Acting Director of Airports, the Executive Assistant of President and Deputy Unmanned Technology Officer, and CEOs from several companies with a significant interest in UASs all attended. Although not clearly defined, the issues discussed revolved around on of the following categories defined in a literature review by Luppicini and So in 2016.

This literature review lays out eight categories of concern that UASs face. Although based solely on articles and news stories related to commercial UASs, these reoccurring categories seem to be extremely important. Topics discussed at the symposium, the categories that UAS reporting agencies use for their news stories, and the interviews conducted to support this study all align with this construct: safety, ethics and morals, legal, privacy, airspace, information integrity, human versus machine, and commercial related (Luppicini & So, 2016). This IA is not designed to analyze these issues in depth, but they must be mentioned since several of these issues will shape the course of business for UAS operators and manufactures.
Discussion

The UAS industry is undergoing a rapid succession of change, particularly in the technological and legislative arenas. Although UAS technology was advancing, it is the readily available small UASs built by companies like Parrott and DJI that have upended the environment and forced government into action. Almost weekly a new technology or local ordinance is released, and monthly a major announcement by a significant stakeholder seems to shake up the industry and the assumptions that underlie it. In late 2017, President Trump sent a memo to the Department of Transportation, directing them to make it easier to fly a commercial drone. In March of 2018, the acting director of the FAA announced LAANC, a partnership with industry that completely changed the way Part 107 certified UAS operators received clearance to fly, reducing clearance times from upwards of 4 months, to just minutes. By the time this IA is published, many parts are likely to be outdated and will serve more as a historical snapshot of the industry and the status of the challenges faced.

One upcoming legislative piece that may alter or even completely upend the foundations of this study, is the FAA Reauthorization Act of 2018, introduced by Representative Shuster. This act has provisions within that may upend model aircraft exemptions in section 336, levy fees to UAS users to pay for regulatory oversight costs, create an Unmanned Aircraft Traffic Management System (UTM), and updates sections of Part 107 to allow UASs to carry cargo after meeting still to be defined safety requirements (Rupprecht, 2018). Still under review and debate at the time of this paper being written, these provisions may or may not still exist in the final version, and others may be added.

Despite this, the relevancy is still clear as it serves to summarize the industry in its current state and lays out the major challenges that must be overcome to reach full potential. As UAS utility increases and companies and governmental agencies find new uses for them, new challenges will arise, but the issues
will likely still fall within one of the eight constructs described in the General Public section above. Many of these challenges will take years to settle, with particular issues like privacy requiring the eventual intervention of the Supreme Court of the United States. This is nothing new, but it is new to UASs.

Helicopters when used for surveillance by law enforcement required a Supreme Court ruling in 1989 to determine if that use complied with the Fourth Amendment dealing with unreasonable search and seizure. The courts found in that instance that:

Because there is reason to believe that there is considerable public use of airspace at altitudes of 400 feet and above, and because respondent introduced no evidence to the contrary before the state courts, it must be concluded that his expectation of privacy here was not reasonable.

However, public use of altitudes lower than 400 feet -- particularly public observations from helicopters circling over the curtilage of a home -- may be sufficiently rare that police surveillance from such altitudes would violate reasonable expectations of privacy, despite compliance with FAA regulations (Florida v. Riley, 488 U.S. 445, 1989).

The ruling is just one example of existing law that will impact how a stakeholder uses UASs and to what extent, and what may need to happen to allow these systems to reach their full business potential. Law enforcement officials are in a precarious situation with UASs as a result of this ruling. The airspace below 400 feet was not used significantly by the public in 1989, but today the proliferation of UASs by the public at these altitudes may have changed the environment enough to overturn that portion of the decision. By the time that the FAA Reauthorization Act of 2018 reaches its final version, this issue may be included, but even then, a final ruling by the Supreme Court will be required to finalize the legality.

As technology becomes more reliable and can prove that safe UAS operations can occur, and as legislative issues are resolved, oftentimes with technological advances that are brought to market by
manufactures, UAS use will become more prevalent. The impact of UASs on the economy and everyday life is nearly impossible to imagine given today’s climate and the multitude of challenges that have yet to be solved. What is certain, is that to solve these problems, all of the stakeholders listed in this IA must be considered and involved in the process for the UAS Industry to reach its full business potential.

Conclusions

In March, the FAA stated that they estimated that 2 million midsized UASs were in the United States, and the data seems to support this. Estimated sales figures, show that 2.4 million UASs for both personal and commercial were sold in 2017 (Meola, 2017). Many are sub $100 models from the local drugstore or megastore, weight less than half a pound, and are flown once or twice then forgotten, but over 40% of UAS sales are for those over $300. This means that 960,000 small to mid-sized systems were sold just in 2017. Sales appear to double every year, so in 2016 there would be 480,000, and 2015 240,000, netting nearly 2 million systems still operational in the United States. If “more than two-thirds (68%) of all drones weighing over 250 grams are purchased for professional purposes”, we then have about 1.14 Million UASs for commercial purposes in the United States (Snow, 2017). In Sept of 2017, the FAA showed just over 100,000 Certified Part 107 pilots, so there are 1.14 Million UASs for commercial purposes, and only 100,000 certified pilots. This is a major issue for the budding and rapidly changing UAS industry.

Commercial aviation is less than 100 years old, and the FAA in its current form, which emphasizes “Safety First, Last, and Always”, was realized in 1958 with the passing of the Federal Aviation Act (FAA, 2017a). The culture that developed over 60 years with a focus on safety is not arbitrary, but rather the result of the public’s desire to travel or be near aircraft with little fear of injury or death. Professional aviators comply with FAA regulations and maintain a culture that aligns with this desire for safety. If
only 100,000 small to medium sized UAS operators are complying with FAA regulations, that then leaves over 1 million UAS pilots flying for commercial purposes that do not.

The changes we see today in the UAS Industry, and the pace at which these changes are occurring, would not be possible without small to medium sized UASs, but it is also these UAS operators that fall into the category of non-compliance with FAA regulations. The larger UAS systems and their operators will ultimately benefit from the increased interest in accelerating legislation to allow UASs to operate commercially in the United States, but the non-compliant operators also threaten to erase this forward progress with a single accident. Until legislation is solidified and public exposure and opinion is sufficiently positive surrounding commercial UAS operations, this industry remains primed for great growth and success, yet poised for significant restrictions and public scrutiny.

Ultimately, the laws are only as good as the enforcement actions taken to reinforce them. The preliminary interviews conducted that started this project indicated that there was insufficient enforcement of existing law, so it would be unreasonable to expect the introduction of new laws to solve all the issues. It is the professional aviators who follow the laws that suffer in the short-run, as unlicensed “fly-by-night” individuals undercut legitimate businesses, but they are also the ones who safely provide complete UAS solutions that provide reliable data and real value to consumers. They are the ones who are partnering with the FAA to rewrite legislation to make safe, legal operations possible. In the long-run, it is the professional aviators who will be able to leverage the full capability of UASs for the greatest benefit, and will see exponential growth in a yet infantile industry.
CHAPTER TWO: EXPLORING IMPEDIMENTS TO THE PROLIFERATION OF COMMERCIAL UNMANNED AERIAL SYSTEM USE IN THE NATIONAL AIRSPACE SYSTEM OF THE UNITED STATES

Note to Reader

The following chapter was published by this author in the Muma Business Review, Volume 2, Number 9, on pages 106 thru 121 on November 1, 2018. It is reproduced with permission under Creative Commons Licensing.

Tagline

Unmanned Aerial Vehicles (UASs), best known as Drones, are expanding in their use, finding new commercial applications and honing their abilities in existing applications. The interviews analyzed here are designed to understand why UAS use has not reached its full commercial potential in the United States.

Keywords


Executive Summary

The UAS industry is experiencing a rapid expansion, doubling every year since 2013, as adopters of this disruptive technology find new ways to benefit from these aerial platforms (Spencer, 2018). Of particular interest is the use of small to medium sized UASs, with a cost to the user of less than $2,000 that are the
catalyst for this growth. Despite this rapid growth, UAS operators claim an inability to use these systems to their full potential due to regulatory obstacles.

A collection of industry experts were interviewed to discuss the UAS industry, and to explore these perceived obstacles that may be hindering an increased use of these systems across the United States. Represented in the body of 12 interviewees were UAS operators, academic experts, UAS reporters, and legal and regulatory professionals from across the country with on average at least five years of experience in UASs, and at least 10 years in aviation to provide a breadth of experience and array of viewpoints.

**Introduction**

Despite the explosion of popularity of UASs, and the recognition that such systems must find a way to safely operate alongside manned aviation, a literature review by this author as well as interviews with three commercial aerial photography companies in Tampa Bay, Florida, indicate that regulatory restrictions are still the greatest obstacle to law abiding commercial UAS operators. It can take six to eight months with a backlog of 12,000 waiver applications to get either a Part 333 or Part 107 exemption, which grants FAA permission for a commercial operator to fly a UAS inside controlled airspace (Gardner, 2018). A manned pilot can file a flight plan and hover a helicopter over the same area in just a few hours.

The purpose of this research was to determine what industry experts perceive the future of UAS regulations hold, and how the industry will be impacted in both the short term of 5 years and less, and long-term of 5 years or more. UAS industry expert interviews were conducted in the “reflection of the meaning”, semi-structured style, with each interviewee given the latitude to discuss topics as they came to mind. A preset approved bank of questions helped to guide the interview, but in many cases as experts in
the field, the interviewees naturally discussed the topics covered in the preset questions and the interview adapted to avoid unnecessary repetition. One interview was conducted in-person, but the rest were via phone calls due to geographical separation.

**Interviewees**

Twelve individuals were interviewed for this study, and include over 206 years of aviation experience combined. Interviewees averaged a little more than 17 years per interviewee, with even more professional experience outside of aviation. The highest member had 50 years of aviation specific experience in a variety of roles, while the lowest had just two and a half years.

![Interviewee Years of Aviation Experience](image)

**Figure 4: Interviewee Years of Aviation Experience**

Although the initial goal was to interview from three categories, it was found that the experience of the experts in the field did not easily fall into the defined categories. As a result, the initial three categories were expanded to four, since they did not portray the industry as accurately as desired. In many cases, an academic was also a legal or regulatory expert, or an operator was also a regulatory representative. Instead of categorizing interviewees into one specific classification, the following chart was created to better show their expertise and backgrounds. An individual was assigned a value from in each area based on their level of experience, with a total possible score equal to years of aviation experience.
The four categories were each represented by interviewees, with the charts above and below better depicting their backgrounds than a simple categorization would. The pie chart below shows the cumulative experience based on years of experience in each of four categories, but does not differentiate the quality or diversity of this experience as it is impossible to measure given this study’s limitations. Based on this author’s 18 years of aviation specific experience and educational background, he finds this dispersion of experience to be a highly valid representation of the UAS industry as it relates to regulatory issues.

Each interviewee is listed below with a brief biography highlighting individual experience.
Interviewee 1 An Associate Professor at Embry-Riddle Aeronautical University and a certified corporate pilot with over 5,000 flight hours.

Interviewee 2 President of a consulting company, former Professor of Aviation with six years devoted to unmanned systems, member of several FAA-sponsored aviation rule making committees, and practicing attorney for 28 years.

Interviewee 3 Assistant Professor of Aeronautical Science with seven years in the U.S. Air Force.

Interviewee 4 Team member at the UAS Integration Office Research Division of the Federal Aviation Administration with experience working with the U.S. Navy in manned and unmanned aircraft.

Interviewee 5 Editor in Field at an online UAS news company, member of several Federal Aviation Administration’s Small Unmanned Aircraft Systems Aviation Rulemaking committees.

Interviewee 6, Director of Commercial Drone Services at his company and member of the National Board of Directors for AUVSI. A former pilot for the Navy.

Interviewee 7, Business Development Executive at his company with 50 years aviation experience. Experience as an instructor and corporate pilot.

Interviewee 8, Corporate Communication Director for UAS manufacture with over 20 years of experience as a journalist.

Interviewee 9, President of his company, retired from the Army with a majority of his career in a Special Operations Special Mission Unit.

Interviewee 10, Currently an attorney in private practice, with over 10 years of experience at the FAA with a majority of that in the regulation of Unmanned Systems.

Interviewee 11, Vice president of Operations at an International Airport with 29 total years of airport management experience. Created first agreement at a major international airport in United States to operate UASs, with the cooperation with a major airline.

Interviewee 12, Former Vice President of Regulatory and Legislative Affairs at the American Association of Airport Executives (AAAE).
The Interview

The interviews were conducted in the semi-structured interview format. Although an attempt was made to keep each interview as similar as possible to each other, there was variation as interviewees discussed their experience. Some subjects kept their answers brief, while others gave more elaborate answers which tended to lead into discussions that would have been asked at a later point in the interview. Due to this variety, the planned questions that appear to give the greatest insight are listed below, and the answers that relate most closely to them are summarized within these questions. This is so even if the answers were not given as a specific response to that exact question. The first three questions are background gathering / icebreaking questions, and the answers to these questions are summarized in the previous section that describes each interviewee’s background. Question 4 begins to dig into the experiential portion of the interviews and each question has excerpts from each subject that best encapsulate their response, followed by a brief analysis of these answers.

Q1. How long have you been in your present role with (company), and what role do you play?
Q2. What unique skillsets and experiences you have best prepared you for your current role?
Q3. How long have you used UASs in your company and how would you say they contribute to your ability to conduct business?
Q4. Looking back, is there anything in particular that really sparked your interest in Unmanned Systems, and if so, could you elaborate a bit?

Table 3: Q4. Looking back, is there anything in particular that really sparked your interest in Unmanned Systems, and if so, could you elaborate a bit?
Table 3 continued

#1-...how I ended up in this area is that I was formerly a corporate pilot. But my education, my graduate education led me into the remote sensing aspects. I cross-teach in both unmanned aircraft systems and aeronautical science. I feel like it gives me a unique perspective with students seeing them on one side in manned aviation and then the other side, the unmanned aviation, and where they clash with automation issues or regulation and detect and avoid. All the different dynamics that are melding the two together right now.

#2- I've been in commercial unmanned aircraft for about 15 years. I got into it as part of an existing business. I was a remodel contractor and I'd already been doing hobby stuff for whatever else, digital cameras, put them on the planes, fly them around, aerial photography of the construction sites, condo projects, real estate.

#3- Well, it's one of those things that as your experience in the Air Force is probably similar; as somebody's looking for volunteers, and you stick out your hand, and it sounds like it would be something interesting to do, and next thing you know you're embedded so deep you can't get out of it. That's what happened…

#4- The primary interest for unmanned aviation came from the fact that, really, we're seeing a rebirth of aviation. So, 1903, the first heavier-than-air flight with the Wright brothers. We're seeing a complete rebirth, where this is the first really, truly new thing in aviation since the early 1900s. And that fascinated with me because we haven't figured everything out yet. In fact, we've figured very few things out. That's one of the things I love, is the ability to go into a new element of the industry and try to figure out, how do we do this? And how do we do this safely?

#5- No, not particularly. It's just something that, I guess, has been building more and more momentum as I've been going throughout my career. I mean, it was always strong on the DoD side, but then working over in the FAA side, it's something that's definitely been gaining more and more steam as the years have gone by.
Table 3 continued

#6- Well we saw internally, that our...most of our revenue is derived from Navy contract efforts, so in the federal business world, if we're tied to federal contract, and that's a good news, bad news story. There's not much diversification in it, so as DOD budgets go, so goes private industry that supports that industry. Military efforts, specifically, Naval Aviation efforts. So if a major program that we were supporting gets whacked, and whacked meaning budget reductions or program termination or a number of other things, we're gonna be subjected to that ripple effect of how it flows down through everybody that supports that particular weapon system or that contract. And so the company wanted to diversify, we already do drone work for the military. We do a lot of manned aviation work for the military, mostly Naval aviation. And so, it was a natural fit to then grow our commercial side of the business and use the experience we have in the highly credentialed and certified aviators that we have in the business, and use them for potential job opportunities for the commercial drone world.

#7- No, just the opposite. I really had zero interest in it 13 plus years ago. Well, actually, probably closer to 16 years ago because he started trying to woo me into this business way back before I was even ready to consider it. I guess, to be perfectly frank, I got into it more out of my friendship for Steve. His company needed help, my background was in flight training and flight operations, and he desperately needed someone to kinda get things back on track for him. So after 30 years with the university they were getting ready to change presidents, and I'd already been through five of them, I didn't really feel like going with another so I basically spit the hook. I was a tenured full professor there, along with being a VP. It was just time to make a change. I had no particular interest in unmanned systems at all.

#8- [I] was recruited to join DJI. I don't have a traditional tech background or experience in tech PR, per se, but a lot of my background is in dealing with the governmental issues that arise with complicated policy questions about new technology. That's increasingly an issue facing drones, how they're going to be regulated by the FAA, how drones how to be considered
Table 3 continued

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<th>#9-</th>
<th>I realized that we needed a differentiator to set us apart from the other companies, and that's when we started really looking at bringing in small, unmanned aerial systems into our core area of expertise. We would blend the unmanned aerial systems with what we do for specialties in Intelligence, IT, Cyber Security and Special Operation Forces training. It would be important to leverage the operational integration piece and really focus more on type I and type II size UAVs, which are under 55 pounds, non-program of record type aircraft.</th>
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<td>#10-</td>
<td>I was with the FAA prior to that for almost ten years. At one point, our office needed somebody, I was in the chief counsel's office. Our regulations group needed someone to work with our unmanned aircraft systems office. At that point then I was the- worked primarily on drones for the last three years at the agency and was the liaison between the UAS integration office and the chief counsel's office and worked on a lot of the…on the 333 exemptions, on a number of different policies and practices that the agency developed.</td>
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<td>#11-</td>
<td>In my position here in DFW, I was just really the point person for a lot of UAS activities. And the reason I ended up in that position is because of my knowledge of air traffic control procedures, 7110.65 specifically. And trying to look at FAR Part 107 and how it's applicable to UAS operations in a Class B airspace environment.</td>
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<td>#12-</td>
<td>Well, it's really simple. At triple-A E, I was responsible for operation, safety, planning, emergency management, experimental aircrafts, environmental services, general aviation, UAS, ARFs, airport rescue and firefighting, among a number of other topics. So, while my passion is really in UASs, my job really was quite broad and it was difficult to maintain the focus and to keep on the cutting edge of the industry with having to keep track of so many</td>
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other things. It was really about a passion for unmanned aircraft systems and integration of policy associated with it, and just wanted to be able to focus more on that.

Of the 12 interviewees, two of them, #4 and #12, appear to have had a desire and interest in UAS which drove them to acquire specialized skills and knowledge in the industry. With the other 10, their involvement was more by chance or in some instances involuntary, but the recognition of the potential for growth, or the impact of the evolution of the UAS industry was having on their industry, led them to become more involved with UASs.

It shows that there is something other than a love for the technology that is gravitating these individuals to this sector, and also could indicate that these individuals are not set on the technology itself, but the ability of UASs to provide solutions to problems in pre-existing industries. If this is true, then their perception of the industry is less likely to be skewed by a desire for the industry to succeed, and could indicate a high reliability in the quality of their responses during their interviews.

Table 4: Q5 Where do you see the UAS industry in the next five years, and what kind of things do you see UASs doing as the industry develops?

#1 - so you can see how that's dynamically changed over time. Five years ago, it was probably 97% DoD. Now it's 97% civilian sector, and those DoD applications are still there, but we see all these technologies coming over...

When you look at growth with linear infrastructure, vertical infrastructure those are the areas where we're going to see growth. Now, looking down range into the future, then we start enhanced capabilities and that technology from larger aircraft integrating into some of the
manned platforms that we have. Manned aviation is becoming more and more autonomous. It's already in everything, self-driving cars and self-driving trains, and everything. I think that airplanes are going to be no different in that respect.

We're going to see that technology being integrated into smaller aircraft and then ultimately large transport category aircraft. I think it will follow in some ways the same route that deregulation did with integration, through proof of concept and then integration into normal, mainstream air carriers. That is, of course, down the line, but I think it's inevitable that's going to occur.

**#2-** I think the industry has a lot of promise. I think that we can do a lot more and we can use this technology to do a lot of the things that you hear about as far as we are concerned. I'm going to say this though. Drones are not magical. I don't think drones are going to be the cure all and fix everything we want them to fix. It's just the business models just not there and I think people have been a little bit over optimistic. They've hyped it too much. I don't think we'll ever reach all of those goals. However, they will help us be better stewards of a planet with diminishing resources, help us feed a hungry world, things like that. I think that's really where the promise is, like drone delivery and burrito delivery and stuff. I mean, its novelty or whatever. I don't really need a drone to deliver me a burrito. I don't really think the Amazon model makes sense.

**#3-** It's happening now in a way. I mean, there's experimental programs for the package deliveries. They're talking about taking medications or other emergency material out to a remote area, like on an Indian reservation or out in the country someplace or in the forest where somebody might be stranded or lost. They're doing that on an experimental basis. The other more practical uses such as power line or pipe line inspections, building inspections, construction and then on the public safety side, law enforcement agencies using unmanned systems for search and rescue, for accident reconstruction. They're not supposed to be using
Table 4 continued

them for surveillance or even evidence collection, but they're using them extensively for backup for night operations.

I think you're going to continue to see a growth in the use of the systems in an industrial side where they're ... I just got off the phone a couple hours ago with a client that's going to do power line inspections they're seeking a waiver of one specific section of part 107 to be able to fly their aircraft without a visual observer on the ground. That's not an impossible challenge for me. I'm sure we'll get a waiver for that from the FAA but, the arguments for using this kind of a system as opposed to having a human being climbing up a power pole or a cell phone tower is that, I think the last statistic I heard that in one year the telecommunications industry had 70, I think this was four years ago, 72 or 76 deaths of men, from primarily falling off of towers doing inspections. One death is unreasonable but 72 is just outrageous. They want to put an end to that and they wanna use these systems to be able to conduct the required inspections of these infrastructure without endangering lives. That's where the growth is gonna be is using the systems that are really too dangerous for a human being.

#4- The big thing on everyone's lips right now is the Beyond Visual Line of Sight authorization, which is the ability to fly beyond just the local area of the operator. I think that's going to come out within the next five years, probably within the next two to three years, if we're realistic.

I think, once that element of the industry is flushed out, we're going to see some really dramatic growth, primarily because you have industries that want to perform deliveries and do other sorts of functions, that can't be done close-by to an operator, so that ability to have that remote operation taking place is one of the key. I think once that happens, we're bound to see even more growth than what we're at, and, if I remember correctly, and I don't know if I have the statistics right off the top of my head, but we're looking at an industry that is going to be in
the billions of dollars in the next several years. And I don't think that that's going to be the ceiling. I think it's only going to continue to expand as the regulatory structure allows it to.

#5- That's a difficult one, because it really depends on what rules we can get in place, but with one of the new presidential programs that we're working on, I see us actually working and accelerating some of that integration in specific areas of the country, so I think in the next five to seven years, you'll actually see some trial package deliveries out there, and also more integrated, I guess with different industries, that rely on UASs that I am thinking of, like insurance and then search and rescue. I think UAS will be used a lot more often. It'll be a semi-regular thing to see in certain parts of the country.

#6- I see a continued push towards greater levels of automation. So there will be an ability for a drone in a box type scenario. That's the most simplistic example where you push a button, the box opens up, the drone takes off and flies an inspection of an industrial facility. Whether it's for security or whether it's using sensors on more the drone to detect leaks or a number of things, then the drone returns back to it's nest or box, lands and recharges. Or swaps payloads and goes back up, flies it again. That entire flight operation is with minimal human in the loop intervention. Maybe zero, maybe other than pushing the button that says go. Maybe the entire operation is almost fully automated.

#7- [Consumer use] I've always been of the belief that particularly at the consumer lever, these systems that FAA and others have been so nervous about, the volume of that activity will clearly wane… there's clearly a decline. [Professional use]…what you are seeing though is increase. A fortunate increase of the use of these systems for legitimate professional reasons. Using them to save lives. Using them to collect information that can better mankind. Doing the kinds of things that they were designed to do. The hobbyist, the recreational user community. I always categorize these things much like the old pet rock. Its new technology, everybody loves it, its really cool when it first comes
out, but how many pictures of your roof can you take? After a couple of flights, these things go
into closets. They're just not out there. But the professional users, that's the ones we really want
to concentrate on. I think you're clearly going to see that shift in the volume of activity and the
makeup of that activity to far less recreational and far more professional in its application.

#8- It's easier to see the increasing automation, actually the increasing capabilities on the
hardware side. Drones that can fly faster, farther, in worse weather that have better sense and
avoid capabilities, et cetera. In many ways the bigger challenge for widespread adoption of
drones in enterprise uses is what happens with the data they generate because a drone flying in
automated routes is a data collection business. A job site, for example, is going to be gathering
an awful lot of data over time, a lot of imagery that has to then be downloaded from the drone,
uploaded either to a desktop computer or to a cloud server, or the processing that comes from
that and the organization that captured the data. How does it manage that? What if you're a
construction company with a fleet of 12 drones and they're out flying every day? How do you
start gathering all that together, providing smooth work flows?

#9- So there are so many things that are going to happen. It's very similar to the invent and
proliferation of the internet globally or cell phones when they came of age. You and I know
that it was in, I don't know what year, we had the bag phones we had in our cars that not that
many people would use, because they were so expensive and they were big and heavy and
people thought, "Why would you need something like that?" Now, you can't live without them.
If you walk out the door without your phone, it's more important than the keys to your car. So
it will be similar, only on a much grander scale, with UAS technology. I don't think it's just
UAS technology, I think it is all things unmanned, internet of things and artificial intelligence.
So all of those things combined are going to make tremendous advances over the next 5, 10, 20
years. I think what we're going to see is not just the UAS technology that will continue to
advance, I think concurrently there will be mass distribution of product and services being used
Table 4 continued

by unmanned systems on a commercial scale. There will be much greater militarization of unmanned systems in the battle space. President Trump recently signed into law H.R. 5515, the John S. McCain National Defense Authorization Act for Fiscal Year 2019, authorizing the U.S. Department of Defense (DoD) to spend $9.6 billion for unmanned vehicle systems. The bill increases military spending for unmanned technologies by 28 percent over last year, according to an analysis by the Association for Unmanned Vehicle Systems International (AUVSI).

#10- I think the short term is going to be linear inspection when that use becomes regularized when there's some finally some regulation or some other way that allows routine use of beyond line of sight and over people that a construction company can survey their site while their workers are continuing to work and don't have to shut down operations or go into off hours for the electric utility, inspecting the power lines, pipelines, and the lights. And I think that within the next 3 years that will become routine and I think that's the short term. The long term we're talking about- I don't know, that's kind of an open question. Its been so much focus on this immediate need, right, and small UAS, but I think there's starting to be some look at flight within larger vehicles, flight within intermingling with manned aircraft at the flight levels or other places. I guess implementing systems to make that possible. So, whatever that looks like, as you know, anything that you can think of and more can be done with a drone. So we're not yet, haven't yet discovered all the potential uses for them.

#11- You're going to see a lot more of those applications, pretty much video and still photography. I know that utility companies are going to use the UAS to inspect the pipelines and transmission lines. That is applicable for a high density metro area. I know there's companies inspecting the top of these wind generators at several hundred feet above ground, but those obviously are going to be nowhere near the airport area.

But there are a lot of practical commercial applications within five miles of an airport. And as you go out a little bit farther, when you get out of that five mile ring, the FAA is allowing you
Table 4 continued

| #12 | I think we're trying to catch fire in this industry. This is the type of disruptive technology that really needs to hit that critical mass. And when you look at it, there are a couple of major components. One of those is the automation technology. Do we have... the technology for automation and aviation and on ground vehicles? The answer is, we're just about where we need to be right now. I actually think once you put that automation technology in the air, it becomes much simpler. There's many fewer variables and scenarios that AI has to contemplate in the air. In addition to that, we've already have seen a high degree of autonomy in manned aviation, especially at the airline level. We're not quite there to where we need to be, or not quite where we need to be. We will be very soon. And we'll absolutely be there by the time, ten years from now [Different question same theme] Ten years from now I think we'd like to see widespread utilization of UAS: flights over people, medical and public safety, widespread public safety flights, and then also package delivery, things of that nature. I think that's very, very attainable inside ten years |

The results from this line of thought are varied, but most subjects except for #12 appear to view the industry with cautious but realistic optimism. Not all interviewees gave specific examples of where the future of the industry may go, and this could possibly reflect the uncertainty that surrounds barriers to growth. Several interviewees, as a part of their answer to this question,
raised concerns over regulatory actions that either needed to occur, or may occur in response to an incident of negative consequences, which can play a major role in the ability for this industry to develop to its full potential.

Table 5: Q6. What are some of the barriers that you think may currently be, or may in the future impede the ability of the UAS industry to achieve this?

| #1- | The regulatory aspects are one thing. We've got other things, we have to worry about when you have widespread integration of UAS technologies that mixing. We have what? 37,000, roughly 37,000 commercial flights a day. You've got to figure out how that affects overall operations in not only the airspace above 400 feet, but the airspace below 400 feet. I think they're taking initiatives of that. But other things that they're looking at besides just the commercialization and the ability to grow with operations are the security aspects, the detect and avoid issues are considerable, and other things that affect the movement of UAS technologies in the mainstream environment are based on society's perceptions and things like privacy and acceptance of automation, those types of things. |
| #2 - | I got to be honest that the 107 from what I knew and from what I was doing on the ARC was very liberal. I thought it was very liberal that mainly I was surprised that there was no practical test for the license. Say that anybody could go buy a 55 pound aircraft or like a ScanEagle and fly it around at 100 miles an hour and they don't even have to prove that they knew how to fly that thing is dangerous in my estimation… The other thing that needs to be done is I think that the community needs to get real. The other thing, and I had this conversation earlier this morning, someone was saying "Well, you know, it doesn't seem like the drone thing is really panned out" like the forecast of 82 billion dollars and all the rest of it and until we get beyond visual line of sight. Well, people want to fly over |
Table 5 continued

people. People want to fly beyond visual line of sight. The engineering, or the meantime between failure numbers on the aircraft are way too low to really think that you're going to be flying over people or being able to fly beyond visual line of sight and there were people that were telling people that in 2015…

#3- Well that's really the $64,000 question. Probably the major impediment is the FAA. I don't mean that as a criticism necessarily, but they were overwhelmed, the agency was overwhelmed and is still overwhelmed by the demand for the use of unmanned systems in a domestic environment, in non-military or non-security. They were not equipped both with man power and just resources to deal with what was going on. There were folks that were out there flying these airplanes really without any regulatory oversight at all and the FAA tried to step up with some policy statements and other ways of trying to enforce their existing regulations. They've behind the curve for quite a long time in developing a regulatory scheme that would address the demands of the industry itself. By the industry I mean, everybody that's out there selling and flying and servicing these aircraft. Against the concerns of the public, invasion of privacy is one of the major concerns for the smaller aircraft and the potential for disaster. There's a lot of, unfortunately been literally thousands of incidences of people flying multi rotor aircraft or quad copters in airspace that should be occupied by commercial aircraft. They're trying to get up close to an airliner on approach into an airport and that hasn't led to a disaster yet, but the fear has been all along that one day some idiot's gonna fly one of these things into the engine of a large commercial jet and it's gonna cause a catastrophic accident that would bring the aircraft down. That'd shut everything down.

#4- I think the biggest thing is going to be data. There's a GAO report that was recently published that criticized the FAA, saying that they're making some decisions or UAS policy based decisions, without data… but the number of individuals, the number of contributors of data to help the FAA move forward is minimal. It's needed. And so, as I think we generate
more of those data points, to show that either the system is working, or the system is not working, will allow us to move forward as an industry.

[Separate question, same theme]…I think the best way to codify that would be non-compliant operators. And basically, there are rules in place that the FAA has already codified, about who can operate UAS, for what purpose, and when. And how. And so all of those rules make up either 14 CFR Part 107, the Part 333 Exemption process, the Part 334 process for public operators, or Part 101 for hobbyists.

So, the problem lies in when you have one or more of these different stakeholders that don't follow the rules that the FAA has laid out, and now you have a non-compliant operator, which basically means they are the ones producing the threat to the national airspace system. And everyone throws up their hands, saying, well, what do we do about these guys? Because a policy or rule may not necessarily be the change that's necessary.

And so those are the people that are really holding up the industry, because, even if they create the right rules, if people don't follow them, we're still at the same point we are before, which is an unsafe national airspace system.

#5- …some of the technology isn't actually there. For the most part, the detect and avoid aspects, they are not where they need to be for autonomous operations or for UAS operations. Then the autonomous piece of operations is another problem, because we see what happens with cars today and they've halted most operations of autonomous vehicles because of the accidents that they've had, and we don't want the same thing that happened with UAS. You've gotta be very cautious of what the public outcry is for the autonomous vehicles for driverless cars, and look at that piece for UAS as well.

#6- So until we get remote I.D. figured out, until we gain the trust and confidence of the security apparatus there in that particular location of the country, then I don't see civil operations under Part 107 occurring any time soon.
Table 5 continued

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<th>#7- we got to solve a few technical challenges. We've got to ... the FAA is ... much like doctors. First do no harm. You could disrupt a piece of technology in the airspace like an unmanned system. Unless you have ways to accommodate and mitigate the risks associated with that, you're going to have a hard time selling the concept. We all want see and avoid, detect and avoid, the 90-1113 requirements. Those are huge. How do you keep one of these things from running into an airplane or being in a place where it shouldn't be? There are challenges there. Particularly when you talk about size, weight, and power issues associated with them. One of the things a lot people forget is that the real product that these systems provide is data. Its not the airframe. Its not the aircraft itself or the system. So much time and effort is spent on developing the platforms and building something that can carry the hardware to satisfy a detect and avoid requirement on the vehicle. And unfortunately, a lot of that is sacrifice of its ability to collect data. The products, what we're really trying to sell.</th>
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<td>#8- Sure. Look, I think everyone needs to recognize that Part 107 was a big step forward for the FAA. It was only a few years before that that they were equally as suspicious of unmanned systems and requiring over the top levels of certification and training for people just to fly</td>
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relatively small systems. They now fully appreciate the potential for unmanned systems. They're also trying to balance an awful lot of interests. They have said a truly horrible potential incident involving a drone will set the entire industry and all the good that it can do back by years. If that happens, everyone who can appreciate the benefits of them loses. They need to ensure that their safety remains the most important value for safeguarding your own interests.

#9- One of the big problems, a big part of all of this, are the rules, laws and legislation surrounding it. What are we doing here in the U.S. to stay advanced of other countries, to keep our technological edge when these other countries may have less restrictive rules, laws and legislation on pilots that we don't allow? Does that then put us behind in technology, because we're not creating the air worthiness or the air systems that are going be able to control how these things will work effectively? So all of those things will be concerning, they're already concerns. Some other big things to consider are personal rights and your right to privacy. That's one of the problems that we have right now with new legislature, policies and laws, and restrictive rules for law enforcement.

#10- Resources is why. The regulator is, is focused right now on the short term but important gains need to be made in overflight of people. So that's one right? There's only so much capacity they can handle especially as their so tied up with doing waivers and exemption requests, and things like that. And so as that they cross the hurdle of, especially ops over people, the overflight, the waiver requests should drop off, bring up more resources. That's one. The second one is really data. That is one of the challenges of the FAA or any agency, any technical agency when their doing rule making is being able to justify, in a rule, what the bases of the standards are putting in place. Why is it safe? How do we know? That’s part of it from what side steps that issue by saying we're going to limit the altitudes of flight. We're going to require people to fly not over people, I guess. You have to have a license or a special requirement. Only fly during the day. You can't be in a controlled air space. They put those
safety parameters around the operation and kinda put a buffer around the operation so that-
because there really wasn't the data to say, "we know it's safe to fly up to 800 feet because of
the amount of aircraft" or "we know it's safe to fly over people because" right?

#11- The number one item that's going to hinder the growth of the UAS is the individuals and
the very few folks who don't follow the rules, don't care about knowing the rules, think they
can fly their UAS anytime and anywhere they want. And unfortunately, that rogue operator is
going to probably be responsible for an incident that's going to cause restrictions and rules, and
really temper down the integration of UASs in the airspace system.

There's people out there that go out and buy a unit and they buy a GoPro. They attach it to it,
they don't know the rules. If they're given the rules, they don't care. And off they go, and they
just want to operate their UAS, thinking that nobody owns the airspace when in fact, the FAA
does.

There is going to be the one individual who has not taken the time to educate themselves on the
rules and regulations associated with operating UAS. They're going to be the ones that are
going delay integration not only here in the metroplex, but all over the country. Because if
something happens, if that incident that we hope doesn't happen, if that happens and there's
significant structural damage or loss of life, there's going to be restrictions put in place
nationwide.

#12- [Paraphrased from comments] Automation Technology, Aviation Technology, and
Integration Technology

Table 6: Q7. If you were king for a day, what is the one thing you would change that
could enable UAS use to its fullest extent?

#1- Well, from a prioritization, I think that it does fall to detect and avoid problems. You have
... Detect and avoid goes hand-in-hand with regulation obviously. When we started to expand
our capabilities to operate near controlled airspace or controlled airspace and in some cases with the proper approvals, but we still don't necessarily have a sense and avoid or a detect and avoid solution that's going to give us positive assurance that no UAS equipment is going to hit a manned aircraft.

#2- My thing with it is, is if you're not going to start making examples of these people no one's going to pay attention to your rules but even worse than that, the FAA looks foolish. We can't enforce what we already have.

#3- It would probably be the airspace management piece of it. To come up with some magic algorithm that would virtually guarantee that a UAS could not under circumstances come into contact with a manned aircraft through any kind of a sense and avoid or detect and avoid system onboard the aircraft or a combination of ground based sensitive void and airborne. They're working on it, sensor packages are in development from a variety of sources to try to solve the sensitive void part of it both in compliance with the regulations and just from a practical sense. NASA's got their UTM program on that aircraft a traffic management system that they're trying to develop a way to manage and then just integrated traffic so that there's no conflicts so that everybody's flying within a designated corridor so that conflicts are avoided.

#4- I think the pace at which the FAA is willing to implement change is slow, and its well below what the industry is ready to do. I think the industry is ready to help make those cases for further expansion of unmanned aircraft into the national airspace system. But I think, to answer your question, if I had a magic wand today, I would change the organizational culture of the agency to match that of the industry. Because the industry is moving at the pace of innovation, and the FAA, kinda understandably so, is, well, barely moving. I think there's concern about making the right decisions, because the industry is chomping at the bit to continue to evolve. And the FAA is very much holding them back at the moment, in my opinion.
Table 6 continued

#5- The one change that would make everything a lot easier in the airspace would, if all airspace in the US was cooperative. We have uncooperative participants, because uncooperative versus cooperative means that everybody has to communicate where they are at all times, and has to send information back and forth to all the participants. If all airspace in the US was like that, it would be a lot easier to actually integrate drones, because then you know where everything is, and you can have your separation distances and be fine. But that's not the way that airspace works in the US, unfortunately.

#6- Batteries. Our lithium polymer batteries have not changed in technology since the 70s when they were first mass produced and so, there's been a better effort of making them more efficient in the form factor that they're provided for, for these small drones. But our number one limitation in the field is that battery, so I could be much more efficient, I could do much more data collection if I had a stinkin' better battery, but they have not come yet. So, as a result, when I deploy into the field, I have to purchase lots and lots of batteries, which are expensive and they all have a shelf life.

#7- They're all a lot of little things I guess. I think it probably would be a better recognition or appreciation by ... I keep beating on the FAA, but what a great target. That they recognize that they are not the end all be all in terms of expertise… … If those barriers were suddenly removed and we could do the kinds of things that we really know we are capable of doing, I would be happy. That would be a good thing.

#8- Look, the safety and security professionals whether it's Aviation Safety, National Security, Homeland Security, local law enforcement. They all want someone to be able to remotely identify drones and quickly determine which, if any, have either are demonstrating malicious intent or are not complying with a remote identification monitoring system. There are authorities that want the ability to say, "Shoot down or disable," a drone that's not compliant with this system. It's a power that we certainly understand why governments would need that in
the most extreme situations, but it brings with it an enormous number of complications. If
government, say, shoots down a threatening drone and it lands on somebody, who's
responsible? How do you apportion blame for that? How do you handle that? All the sorts of
questions that have been worked out over decades for other types of technology.

[Different question same theme] … That's increasingly an issue facing drones, how they're
going to be regulated by the FAA, how drones are to be considered by Congress and others in
government as a matter of providing appropriate protection, protecting safety and security in
that sense as well as regulatory questions about who ought to be able to fly, where and how.

I think it's important that the populace has more knowledge. So organizations like AUVSI
are very good, because it helps to bridge the gap by bringing more information to our
government leaders who can then better understand from the perspective of the pilots in the
industry. AUVSI aides to spotlight what capabilities are out there and what government
restrictions have on our pilots in relation to the evolving technology.

I think that if they can solve the data, if they can generate good data, especially if they can
make a rule making and draw lines that have a rational bases that are supported by evidence,
then they'll be in good shape.

There's always going to be a set of individuals that either A, think the rules don't apply to
them. Or they're knowledgeable about the rules and think they're not going to get caught, so
they just carry on because it's more convenient to them. That's going to be a real issue here if a
drone operator is aware of the rules but says, "You know what? It's really cool to take this up at
3500 feet and go above an airplane and take a picture of it, because that's what I want to do."…
…Unfortunately, it's probably going to take somebody operations a drone to bang one off an
airplane, get prosecuted for it, and put in jail to show that law enforcement and the government
agencies are serious about enforcing rules and regulations that are for the safety of the flying
public. I hate to think that would happen, but human nature says there has to be consequences,
Table 6 continued

known consequences and communicated consequences, for people to change their behaviors after the fact. If you don't get a speeding ticket, you're going to continue to drive 80 to 90, 100 miles per hour because it's my road. Everybody else needs to get out of my way.

#12 - It could take the APA and throw it in the trash. The Administrative Procedures Act. That's the one thing that turns a six-month process into a three-year process. That's absolutely, positively not gonna happen. So I don't even know if it's worth mentioning. But I would say that some keys that I think are actually attainable that really could fix some of the problems, one of them would be remote ID and tracking. That's a really, really, important rule. And if we get it right, that will unlock the door to a lot of the other regulatory issues we need to tackle. But there needs to be some sort of accountability associated with these operations. That way, the public ... Again, where the public comes into play is the security agencies, law enforcement, and so forth. It will give them a higher degree of comfort in this technology if they know that there is accountability associated with these operations. So remote ID and tracking is really, really important. That's one.

Table 7: Q8. What keeps you up at night?

#1- Well, of course, with growth in the number of systems and the growth in the number of people that are buying them, the biggest thing then that I worry about is the increase in the likelihood of an incursion, right? An incursion that could have substantial impact. Luckily, the things that we've seen to date haven't had a huge impact on manned aviation. However, when we do at some point, if we do at some point see some type of UAS activity causing mass casualties as a result of irresponsible operations or just uninformed operations then it's going to be disastrous for the industry.
Table 7 continued

#2- Well, I don't know. It'd be hard to say what the biggest issue is. I think they're all fixable and it just requires the industry to get serious and act like business people. I think what you're going to see happen is the data thing is going to correct itself because there's too many people offering drone services but the quality of data that they're getting is about the same so when people start to realize that the better quality data is going to get you a more professional wage I think that will fix itself. The regulatory thing, I don't really see that fixing itself. There's a motivation issue…

… enforcement needs work. The other stuff, the beyond visual line of sight, all the rest of that, the industry has a lot of work to do if they want to do all that. I think it's doable too. You're just going to have to use science and it'll be baby steps. When you have an aircraft that's quasi reliable then we can talk about flying over people, stuff like that so I think mostly they'll fix it. The real stopping is the regulatory side of it.

#3- Security. The largest manufacturer, commercial manufacturer of unmanned systems in the world is a company based in China, DJI. They collect data, operations data as the aircraft are being flown. I have one of their systems that I've just fooled around with. I don't do it for pay or anything like that but I bought one just so I knew what I was talking about and if you log on to the app and operate the aircraft connecting to their system then they're collecting all that data including video images. DJI denies that they're doing anything with that data and that they have any interest in analyzing whatever it is that's being collected. I'm not sure I believe that. That's a worry.

#4- the non-compliant operators. In the area of research that I specifically focus in, we're seeing a number of trends and visual sightings of unmanned aircraft by pilots, which basically is, not a direct barometer, but I'll call it an indirect barometer of a lack of safety in the national airspace system. In other words, drones and pilots are coming into closer contact with each other, where they shouldn't be.
Well, it's always the people that you can't regulate, and the people that just will go out there and do whatever they're gonna do with the drone, because they don't think it's gonna cause any harm at all, and we've seen a couple incidents where it has caused ... Well, thankfully it hasn't caused any deaths or anything like that, but it has caused harm. There was an incident in North Carolina where a helicopter pilot, they were on a training exercise and a drone came out of the treetops and they had to maneuver away, and they ended up crashing into, I think, the helicopter because of it.

Statistically it's going to be a catastrophic event. Meaning, there's fatalities involved because of a drone. Or at least that's how the news will report it. Worst case scenario would be a commercial airliner is hit by a drone as the commercial airline is taking off or landing at an airport, and is unable to recover so lives are lost. And it is determined that the drone was where it should not have been. It most likely as a result of a recreational operator who just did not have the awareness or the understanding of the air space and was flying somewhere where that person should not have been flying their drone. And as a result, much like we've seen with the autonomous ground transportations, with the Tesla's, anytime there's a fatality in one of those vehicles, even though there's tens of thousands of hours in those vehicles with zero incident, it just takes one to really put the industry on its heels.

Yeah. We certainly don't want the ... one of the thing we ... I just came out of a board meeting with AUVSI last week. We talked about messaging should the balloon go up and one of these things hit an airliner and kill 200 people. Is there a possibility that can happen? Yeah, with some of the knuckleheads that are out there flying these systems in places they should not. That always looms out there. Should it occur, how much of a setback is that going to be for this industry? How do you manage that message? How do you ... again it gets back into that public perception discussion we had earlier. How do you convince the public yeah we just lost 200
lives, but over the course of ten years how many lives did these things save? There's risks with everything

#8- I'm more worried about what are the policy implications if there is a decision that makes it suddenly very difficult for people to use drones either for fun or for beneficial professional uses. The overwhelming majority of drones are flown safely and responsibly. People want to do the right thing. They don't want to create a hazard. They don't want to create a privacy problem. They don't want to alarm anybody. They don't want to bother anybody. There will always be outliers. There's going to be outliers with anything. But the evidence to date shows that this is an astonishingly safe technology that an awful lot of people enjoy.

#9- I can take somebody that we interviewed to come in as a pilot who has never been a UAV pilot before and teach them, and actually, they can self-teach within a day or two by giving them basic expectations; "These are the things that you'll have to know and understand before we can consider you". They have the ability to go and purchase parts and pieces for very low cost to create a flying system and if they know anything at all about homemade explosives, they can create a remotely operated munition. They can weaponize that aerial system and they can cause an International incident with only a week's worth of study through material provided on the internet. So that, to me, is very concerning. The reality is most anybody could do that.

#10- I think it's that safety and security piece. How do you prevent sorts of action like- drones present such a- think about a situation where somebody can have sort of drones or handful of drones in the truck of your car and drive somewhere and launch them out and do something with them that's nefarious or bad or whatever. How do you prevent that? I think that's the biggest question for me and I think overall too, I mean I don't know what the real risks are but in terms of what the security community says that that's something that's out there. You can

Table 7 continued
access and get to a level of access that you wouldn't have with a manned aircraft or a vehicle, a car or automobile.

#11- The easiest one is from an airport operator perspective. It's a collision. And from an FAA perspective, it's a collision. And I have to think, obviously from an airline operator, it's a collision. And to some extent, from a commercial business operator who's operating a UAS in support of their for-profit corporation, that would have to be it, is a collision.

Nobody knows what's going to happen if a drone collides with an airplane. Nobody knows. It might hit it in a non-critical area and bounce off. It might gash the fuselage and the airplane might be perfectly flyable. And I'm just not talking about a Boeing 737. I'm talking about a Cessna 172 carrying a family of four. It also might hit the airplane in the wrong place to render control surfaces inoperable, and then we have an uncontrolled flight into terrain, and then we have some serious issues to deal with.

#12- The security aspects. There's a couple of ... Definitely the security aspects about it. It is extraordinarily easy and it's almost a miracle it hasn't been done, but someone could very easily attach an incendiary device or worse, biological or radiological payload to a drone, and drop it right in the middle of a stadium. Right now, there's virtually nothing we could do about it.

You're talking an incident that could easily cause a massive loss of life. And it would be extremely low-tech. Well, I should say, it's fairly high-tech but it's easily available technology, and at very low cost. Then you could even multiply that by ten or 15 devices easily and create really a mass casualty incident. That, to me, is extremely daunting.

The other thing, similar vein, the nefarious actor that could put one of these things in an aircraft engine, or a swarm of them in an aircraft engine and take down a major airliner with a couple hundred people on board. That's plausible as well. And I think that's a major danger.
Discussion

There were initially 15 interviews planned for this study, but as they progressed and the 12th interview was completed, the answers from the subject matter experts became repetitious and saturated. As a result the interviews were halted and an analysis of themes using Nvivo software to manually code first via open coding was conducted. Each interview was evaluated a minimum of three times prior to attempting to analyze the resulting themes. The first round of analysis is shown below in graphic form, depicting the frequencies of each theme occurring in the aggregate of interviews.

![Figure 7: Round One Theme Analysis](image)

Then through theoretical saturation, the themes were reviewed to hone down to the core properties of the themes. Three central themes emerged through this process: Regulatory, Safety, and Public Perception.
Table 8: Theoretical Saturation Analysis

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<th>Regulatory</th>
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<td>Rulemaking Process</td>
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<td>Industry Evolution</td>
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<tr>
<td>Model Aircraft</td>
<td>Manufacturer Responsibility</td>
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<td>Manufacturer Responsibility</td>
<td>Intellectual Property</td>
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<table>
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<tr>
<th>Safety</th>
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<tr>
<td>Irresponsible Operator</td>
<td>Incursions or collisions</td>
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<tr>
<td>Detect and Avoid</td>
<td>Human Nature</td>
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<tr>
<td>Remote ID</td>
<td>Visual Line of Sight</td>
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<tr>
<td>Manufacturer Responsibility</td>
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<th>Public Perception</th>
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<td>Education</td>
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<td>Large vs Small</td>
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<td>Industry Representation</td>
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To narrow down to these three, all themes were assigned to what appeared to be the root concern addressed by that item. The three themes of Agriculture, Data Processing, and Future did not fit in any of the three categories, but did align with other categories that were appropriately paired with one of the three central themes and were thus absorbed. The tally for the final analysis is shown below.

At first look, it appeared that the safety related themes may fall under the auspices of regulations, and thus be categorized under Regulatory. After closer examination of the interviewees comments related to these issues, the concern for safety went well beyond just the codification of rules, and thus the separate central theme. As for public perception, it was both an issue of safety and regulatory, but added a perception and
understanding element that transcended both. Acceptable safety standards are determined by the public, and then can be codified into law, but these are generally well defined by measureable criteria. Public perception of the different types, missions, and even intent of UASs and their operators is a more malleable topic that requires additional research that is well beyond the scope of this research and is thus ill-defined here and required a separate central theme.

Manufacturer responsibility is the one theme that appears in both the Safety and Regulatory central themes, since the comments in these coded sections were variably undecided and undefined by the interview subjects in a way that lent this subject to both. Every mention of manufacturer responsibility dealt with determining the best ways to provide acceptable safety, and the reasons for this was centered on either the preemption of regulatory action, or the desire to get regulatory action on the topic. The determinant factor for which way the comments went appeared to be dependent on the professional alignment of the individual, which may or may not indicate any influence, and needs additional research to determine if this in fact true.

No matter what the issues discussed by interview subjects, their perception of the industry was that explosive growth and dispersion of UAS technology was inevitable. The rate of growth expected though became debatable, depending on two conditions. The first and most notable was the potential of a catastrophic aviation accident. All subjects who mentioned this were quick to say that it would not stop the industry as a whole, but would significantly alter the growth curve. The second issue only mentioned directly by two of the subjects was the FAA Reauthorization Act of 2018, but the act encompasses almost every issue mentioned by interview subjects not covered under the auspices of a catastrophic accident. This act has provisions within that may upend model aircraft exemptions in section 336, levy fees to UAS users to pay for regulatory oversight costs, create an Unmanned Aircraft Traffic Management System (UTM), and updates sections of Part 107 to allow UASs to carry cargo after meeting still to be defined.
safety requirements (Rupprecht, 2018). Still under review and debate at the time of this paper being written, these provisions may or may not still exist in the final version, and others may be added.

Conclusions

It is almost certain that UASs will continue to expand their role in society and find new ways to impact already existing industries that we can still yet only imagine. According to Michael Kratsios, Deputy US Technology Officer, and Executive Assistant of President, UASs will contribute to 100,000 new jobs and provide nearly $80 Billion in economic impact in the next decade (Kratsios, 2018).

What is not clear, is why they are not already filling the skies and meeting the forecasts that called for UASs to deliver items to your doorstep, or lunch to your place of work. Preliminary interviews hinted that the blame lay with the FAA, so a grounded theory study to determine what if anything was impeding the expansion of the UAS industry was conducted. After an extensive literature review and background study of the history of UAS regulatory action, the research continued with interviews of 12 leading industry experts, with a combined 206 years of aviation experience. The extensive experience of these individuals may indicate if the FAA is causal, or if something else is impeding the expansion of the UAS industry.

Although the technical backgrounds of the individuals interviewed varied greatly, despite these differences the themes of regulatory, safety, and public perception were recurring and present in all interviews. In fact, the balance of these themes, particularly with regulatory and safety are notable. The FAA appears to be only a small part of the equation and is not the root concern of those in the UAS industry.
CHAPTER THREE: OPINION: POTENTIAL IMPACTS OF THE FAA REAUTHORIZATION ACT OF 2018 ON THE COMMERCIAL UNMANNED AIRCRAFT INDUSTRY

Note to Reader
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Tagline
As the Unmanned Aircraft Industry evolves, regulatory actions from Congress will significantly shape the ability to expand and integrate into the existing National Airspace System. The recently finalized 2018 FAA Reauthorization Act has the potential to be the most impactful of legislative actions to date.

Keywords

Executive Summary
The commercial unmanned aircraft industry exists in a rapidly evolving and uncertain environment, with a multitude of well-established, well-financed stakeholders in associated industries each vying to influence that environment. Although influence can come in many forms, Congress holds the ultimate power, and gives agencies like the Federal Aviation Administration (FAA) a recurring authorization to regulate air travel and associated research. On October 5, 2018, this authorization was extended until 2023.

In a variety of draft forms since introduced by Senator Schuster in June of 2017, the FAA Reauthorization Act of 2018 grants an additional 5 years to the FAA, and with it a multitude of new directives related to Unmanned Aircraft Systems (UASs). The House and Senate had versions under review for over a year,
each with unique amendments that impact UAS operations and address many of the concerns of
stakeholders, but not all of them will assist the industry in its efforts to integrate within the National
Airspace system with manned traffic. Some like the Department of Homeland Security, local law
enforcement agencies, and commercial passenger operators all have differing interests that may slow the
growth and integration of UASs. With this final bill, the industry gets the opportunity to operate as it
wishes in some areas, but loses some of the freedoms it once had.

Introduction
This paper is the third in a series of three written to fulfill the requirements of the Doctorate in Business
Administration at the University of South Florida. The first two papers analyzed the UAS industry, and
interviewed industry experts to identify the barriers to the expansion on the UAS industry. This paper
discusses the FAA Reauthorization Act of 2018, which may significantly alter the industry environment
as studied to this point.

The FAA, like all agencies within the United States Government, is authorized to exist and is given
specific directives from Congress and the Office of the President. The FAA is typically renewed for a
period of five years, giving them time to act on new directives and have a sense of stability. For the five
years leading up to the FAA Modernization and Reform Act of 2012, the FAA had no long-term
reauthorization, and had operated under “23 temporary funding measures to continue operations”
(National Business Aviation Association, 2012). It was during this period that UASs were entering the
commercial market, and operators perceived the lack of FAA acceptance as resistance rather than an
uncertainty over the future direction that Congress may give them.

Here in 2018 we again faced the same dilemma. The FAA’s authorization under the Modernization and
Reform Act of 2012 had already expired and the FAA operated on five extensions slated to end in the first
week of October 2018. At Interdrone 2018, a commercial UAS conference and expo held in early September, several FAA representatives stated that they were waiting for Congress to finalize the new authorization bill before they acted in any way to increase UAS integration into the NAS. This approach is in-line with the atmosphere of the period prior to the renewal in 2012. Even after passage, the FAA stated that they are “evaluating the impacts of this change in the law and how implementation will proceed”, and directed operators to continue flying under the old rules until hearing further from them (FAA, 2018).

The FAA Reauthorization Act of 2018, introduced by Representative Shuster in 2017, significantly alters the directives of the FAA regarding UAS operations, eliminates the model aircraft exemptions in section 336, potentially levies fees to UAS users to pay for regulatory oversight costs, creates an Unmanned Aircraft Traffic Management System (UTM), and updates sections of Part 107 to allow UASs to carry cargo after meeting still to be defined safety requirements (115th U.S. Congress, 2018). With such major changes it is easy to see why there is again hesitancy to make any moves until a full analysis of the impacts occurs.

**Opinion**

In the first two papers that analyzed the UAS industry and interviewed industry experts to identify the barriers to the expansion on the UAS industry, initial indications leaned in the direction of the FAA as causal to the perceived slow growth of the UAS industry. This indication was found incorrect and the root stemmed from three factors; Regulatory, Safety, and Public Perception. Regardless, the FAA and the rulemaking process reflects of the safety concerns of the public, and thus the FAA regulations are paramount in the development of the UAS industry, and is the most visible indicator of all three factors.
UASs were a discussion item at the FAA in 2008, but it was not until November of 2013 that they published their first Roadmap for Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS), acknowledging that manned and unmanned aircraft must co-exist. This public acknowledgement appeared to many as long overdue, but when looked at more closely, the FAA was most likely impaired in their ability to act during this time as Congress debated on the very existence of the FAA itself.

Established on August 23, 1958 when President Dwight D. Eisenhower signed the Federal Aviation Act, the FAA is typically renewed every five years (FAA, 2017a). From 2007 to 2012, the period when UASs first transitioned from military to commercial operations, the FAA had no long-term reauthorization, and operated under “23 temporary funding measures to continue operations” (National Business Aviation Association, 2012). Operators perceived the lack of FAA acceptance as resistance rather than an uncertainty over the future direction that Congress may give them. It is difficult to implement new complex processes in any organization, and even harder when continued existence is uncertain, but for outside stakeholders, it is nearly impossible to understand the internal challenges faced in this environment.

Here in 2018 we again faced the same dilemma. The FAA’s authorization under the Modernization and Reform Act of 2012 expired, and FAA representatives stated that until Congress finalized the new authorization bill they were unable to act to increase UAS integration into the NAS. As with the act in 2012, which attempted to significantly modernize the FAA, the 2018 act is attempting to address industry challenges specific to the growing UAS industry and integration into the National Airspace System.

Behind the scenes discussions occurred during this time, attempting to resolve differences in this and Senate version known as S.1405, the Federal Aviation Administration Reauthorization Act of 2017. Ultimately, the resulting bill significantly alters the directives of the FAA, upends model aircraft exemptions in section 336, may result in fees to UAS users to pay for regulatory oversight costs, directs the creation of an Unmanned Aircraft Traffic Management System (UTM), and updates sections of Part 107 to allow UASs to carry cargo after meeting still to be defined safety requirements (115th U.S. Congress, 2018).

Covering the entire act in the span of this paper is impractical, so the focus is on the most impactful changes for both unmanned and manned aviation. Sections that deal with subjects such as the implementation of 24 hour Artic surveillance areas for UASs as they do not change the industry’s ability to evolve are not in the scope of this analysis.

In this spirit, this paper will look at the highlights of how the proposed and somewhat radical departure from airworthiness certifications for UASs, as well as other changes to traditional safety-based requirements specifically for UASs may impact the UAS industry. I will examine how changes to Part 336, which once allowed model aircraft owners to operate UASs without traditional FAA oversight, will change the UAS landscape. A look at other changes to allow law enforcement officials to track and intercept UASs is a must, as are the sections that direct the FAA to develop a certification process to allow package delivery, flight over people, and Beyond Line of Visual Sight Operations (BVLOS). Lastly, a brief look at the Unmanned Traffic Management (UTM) system, designed to create a system “separate but complementary to the FAA's Air Traffic Management (ATM) system” is necessary (FAA, 2017b).
Safety

Much of the FAA Reauthorization Act of 2018 deals with issues related to safety, but there are a few provisions that deal directly with the handling of safety by the FAA. The Senate’s proposal to direct a risk-based assessment process that allows the FAA to grant operations to UASs made the final draft, and allows the FAA to establish a process for UAS operators to self-certify their craft. There are caveats to this, as they must comply with “risk-based consensus safety standards related to the design, production, and modification of small unmanned aircraft systems”, but it opens the door to manufactures so that they may get a certified craft to market (115th U.S. Congress, 2018).

This goes against the strict airworthiness certification requirements for manned aircraft, and may set a dangerous precedent. The checks and balances provided by rigorous testing of new aircraft by an outside regulatory agency such as the FAA is necessary to attain the levels of safety demanded by the general public. Even new aircraft built by Boeing, a company with decades of aircraft building experience, do not always meet FAA requirements. The latest Boeing aircraft, the 787 Dreamliner, underwent several modifications during the design process as directed by the FAA to ensure safety.

What is promising though, is that Congress went on to give some examples of acceptable technologies that must be considered when designing this process, and these examples align with the technologies being tested at UAS test sites and universities across the country. They also require an analysis of safety “in the event that a communications link between a small unmanned aircraft and its operator is lost or compromised”, which is a recurring issue across both civilian and military systems (115th U.S. Congress, 2018). It appears that at least to some extent, Congress tried to open up the airspace but provide checks and balances for the sake of safety.
As shown in previous papers, the two leading UAS manufactures are from China and Europe. If they are allowed to self-certify aircraft, it is unlikely that their processes would meet the current strict requirements of the FAA. In theory the process appears more efficient and is in-line with what industry desires, but it does not meet the needs of Safety or Public Opinion. This provision is likely to face slow implementation as the issues are addressed, and can potentially lead to unsafe UAS operations.

Part 336

Part 336 of the Federal Regulations is an already existing set of rules previous to Part 107 that specifically addresses operations for model aircraft. These aircraft, regardless of their configuration, were exempt from FAA regulation and control under most circumstances, leaving a major gap in their ability to manage UAS operations. When Part 107 was introduced it streamlined the requirements for commercial operation of UASs, and made access to the airspace easier to define, but still neglected to include UASs operated under model aircraft regulations. This loophole is a problem that had to be fixed, and the new act does just that despite model aircraft operator’s objections.

The Act allows for the FAA to continue allowing Part 336 operations as they feel are safe, and adds pilot certification standards and testing for model aircraft operators. It also restricts model aircraft in controlled airspace by requiring them to obtain approval “from the Administrator or designee before operating” and “all airspace restrictions and prohibitions” must be followed (115th U.S. Congress, 2018). These are major moves that will help the FAA gain control of their airspace, and will assist with the creation of a true UTM system. This gets the industry closer to reliable detect, track, and avoidance for all aircraft operating in the NAS, which is a necessary step to allow the UAS industry to reach its full potential. It will on the flip-side, significantly constrain model aircraft operators in ways they have never had to contend with, and deals a major blow to their gains from the 2012 Reauthorization Act.
Tracking and Interception

Title 18 U.S.C., FCC regulations, and other laws prohibit most law enforcement and public agencies from detecting, tracking, and interfering in any way with aircraft. This applies to UASs since aircraft are defined as “a device that is used or intended to be used for flight in the air” (FAA, n.d.). This then makes it complex for law enforcement agencies as it is technically illegal to do much regarding flights of UASs that may endanger public safety or infringe upon privacy. Although it may appear simple to just allow such actions, the very attempt to stop a UAS may induce risk to those below. With nefarious actors learning to use UASs for their purposes, it is clear that something needs to be done to allow law enforcement to act, but the clarity does not extend beyond that.

Congress has decided with this Act to direct the FAA to develop plans to test and certify counter UAS solutions to protect “people, facilities, or assets” such as airports and critical airspace (115th U.S. Congress, 2018). It directs the Attorney General and Secretary to test potential technologies that can “detect, identify, monitor, and track” unmanned systems with the ability to either warn the operator, disrupt control, seize the system, or otherwise destroy it with reasonable force (115th U.S. Congress, 2018). They were careful to insist that any method used was “in a manner consistent with the First and Fourth Amendments to the Constitution”, which was a major sticking point for many individuals.

One disappointing change from the draft versions is the portion that insisted that the FAA coordinate with the DoD while researching these solutions. The military has extensive experience downrange with detecting and intercepting nefarious UAS operators, and can lend that experience to testing and fielding the best solutions. As seen with the interviews conducted in my previous research, the incursion of a UAS into the airspace of a manned aircraft is among the highest concerns of any UAS professional, and finding ways to avoid a major aviation accident caused by either a nefarious or unknowing operator is critical (Spencer, 2018). It is a mistake to leave the organization with the most UAS experience out of the loop in such a critical task, and it is my hope that the FAA does not overlook the DoD.
Package Delivery, Flight over People, and BVLOS

Among the most commonly requested operations by UAS operators is package delivery, flight over people, and beyond visual line of sight operations. These are strictly prohibited under Part 107 operations without a waiver, and waivers are difficult to get approved. The onus of proof that the need for such an operation outweighs the risks associated with it are born only by the operator, and they must show how every possible risk management measure has been taken. Incidents involving collisions with UASs operating outside of these limitations, such as the collision with a UAS and a military helicopter in New York, highlight the importance of conducting operations like this safely. In the instance of the helicopter collision, the aircraft fortunately landed safely, but it could have been much worse.

Section 348 requires that a certification process be established by the FAA to allow for these types of operations, so that they are normal rather than abnormal, as well as safe. The verbiage used is similar to that of manned aircraft certifications, reflecting a cautious yet forward-looking perspective that balances the needs of the industry with that of public safety. Although it does not states what is required to be certified as “safe”, it opens the discussion to a permanent solution for professional UAS operators to attain such a certification.

Technology may be the answer, as there are a multitude of vendors attempting to create various detect and avoid systems that are small enough to fit in a UAS without adding significant weight. The issue becomes interoperability with existing systems, particularly those in manned aircraft. The most widely used detect and avoid technology was developed by NASA is called TCAS, or Traffic Collision Avoidance System. This system tracks other aircraft in proximity to each other, and provides verbal and visual directions to avoid a collision. Although great for manned traffic, the parameters of detection and the actions directed by this system are incompatible with UAS altitudes and operating capabilities. The brute inclusion of this
system without adaptation in UASs will provide erroneous warnings to pilots and cause countless
unnecessary “emergency” avoidance maneuvers. Any technology solution considered must be completely
tested and vetted prior to certification and installation. The Act does well to cover this, as it requires risk /
performance-based requirements to be considered when developing the certification process.

Unmanned Traffic Management (UTM) System
The NAS is controlled by Air Traffic Controllers, in a system known as the Air Traffic Management
(ATM) system. A similar system that is proposed and being studied as of January of 2017 is the UTM,
designed to be “separate but complimentary” (FAA, 2017b). The Act states that the FAA and NASA
“shall develop a plan to allow for the implementation of unmanned aircraft systems traffic management”
that will “ensure the safety and security of all aircraft” (115th U.S. Congress, 2018). The implementation
of such a system is already underway and authorized in previous legislation, but this Act takes it a step
further to address payload and passenger operations above 400 feet above ground level. Companies like
Uber and Amazon particularly will find this positive as they attempt to expand into unmanned passenger
operations and package delivery.

Realizing a UTM is an extremely important step toward full integration and is a mandatory precursor.
These UTM provisions are a welcome note for the UAS industry and do nothing but to push the NAS
toward full integration as desired, but do so at a pace slower than the industry wanted to see. After an
initial pilot program, the FAA has one year to complete a plan toward integration, which once the process
is complete, could take the entirety of the new authorization. Other areas of UTM realization also only
direct the FAA to say if integration is safe or not, and does not direct implementation at any level once the
analysis is complete, so the industry should not celebrate just yet.
Conclusions

Congress passed and the President enacted the 2018 FAA Reauthorization Act despite forecasts that it would to occur prior to the election in November. This shows that the FAA and UASs are a priority for the Hill, despite politically charges debates on Supreme Court Nominees and other issues grabbing the national spotlight. The message is mixed though, as the wording in many sections mandates things that the industry highly desires while giving the FAA the ability to drag their feet in these very issues and delay implementation.

This is a peak into which interests have the greatest influence on lawmakers in the current political environment, and gives us a hint that integration of UASs is coming, although not as quickly as operators may like. What is clear is that the three factors, Regulatory, Safety, and Public Opinion are fully represented in the ongoing Reauthorizations Act debates. The issues plainly address these factors and move the UAS industry closer to full integration once passed, but does so at a measured pace rather than the sprint desired by the UAS industry.

As a commercially rated pilot with over 3,500 hours of flight time in complex jet aircraft, who has dodged UASs on multiple occasions after they intruded on the airspace I was operating in, the slower and more cautious approach is welcome. The safety culture of the FAA is a direct reflection on the desires of the American people, and the threshold of safety that they demand for aviation. In particular, the blanket injection of UASs into the NAS via manufacture self-certification, skipping the traditional certification and testing processes demanded by the people for manned aviation, is irresponsible and goes against the current mandate from Congress, vis-à-vis, the American voter. Once UASs subject themselves to the same, scientifically based testing and certification requirements that manned aircraft must pass, they may then be safe for operations above people, BVLOS, and while carrying cargo that may shift during flight.
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APPENDICES
Appendix A: Chapter One Background

The author is an FAA licensed commercial pilot with over 3,700 hours flying large multi-engine jet aircraft worldwide, and experience in flying four different aircraft. He is also an FAA certified UAS pilot. Although part of the Pathfinder Unmanned Systems team from AeroVironment in the summer of 1997, his interest in unmanned aviation began in earnest in 2008 while completing his MS in Aviation at the University of North Dakota. Under the direction of Dr. Douglas Marshall and Dr. William Watson, he explored the regulatory environment for the introduction of large UASs, operated by government agencies and by experienced pilots, into the National Airspace System. Since then, the introduction of smaller UASs available to nearly everyone has significantly complicated the environment, leading to the need to better understand both how to safely integrate these systems into the infrastructure, and what impact they will have on the marketplace.

To research this, it began with a pilot study that asked UAS operators what they used these systems for, how they saw themselves using them for in the future, and what obstacles they perceived were stopping them from getting there now. This “reflection of the meaning” style, semi-structured interview of three commercial drone operators found that the following four main categories emerged:

- Safety
- Ethics and morals
- Legal / privacy
- Airspace
In the opinion of the business owners interviewed, each of these topics had a common root cause; the FAA and their unwillingness to adapt regulations to support their business. With this knowledge, this author designed a mixed methods / phenomenological study that builds off of these preliminary findings, using interviews with leading commercial drone operators, academics, and governmental agencies across the United States as the primary source of information.

Since the industry has significantly evolved since last looking at it, this industry analysis was undertaken as the first step in understanding the industry as it exists today. Both formal and informal interviews of industry experts were conducted, as well as searches in JSTOR, Google Scholar, and with the assistance of the University of South Florida’s librarians. As an emerging industry, there is very little academic literature that looks at the industry as a whole, and since the number one supplier of UAS systems is from China where there are no requirements to publicly release sales data, the size of the market is left to estimates and the insights of experts.
Appendix B: The IA Protocol

Creating this IA was the result of ongoing interest in the area of UASs for commercial purposes. Many topics were considered, but the end focus on legislative issues is the outcome of preliminary interviews conducted with UAS operators in Tampa Bay. To gain a better understanding of legislative issues, this author participated in the FAA’s UAS conference in Baltimore, Maryland in March of 2018 that focused on the legislation of UASs. Here, the acting director of the FAA stated the “The FAA is open for business”, and that anything that a commercial operator could do, they could do “today”. This was not what the operators themselves said during the preliminary interviews, and was not what operators at the conference were saying either.

This indicated a gap that needed investigating. To do this, this author first searched the University of South Florida’s library for UAS, Drone, or UAV (Unmanned Aerial Vehicle), or related legislative linked papers. Finding very little, the search continued to Embry Riddle Aeronautical University’s library, where again, the topic was sparsely covered, and most studies were specific to a particular technology or application rather than the industry as a whole.

The search then continued to the multiple trade-specific UAS news reporting organizations, and involved the daily reading of articles and releases from reporters, industry analysts, and press releases from companies themselves. It was this combined search paired with this author’s aviation and educational background that allowed this IA to take shape in the form you see here.
Appendix C: Permissions

All interviewees were told before starting the recorded phase of the interview the purpose of and the extent to which their interviews were to be used for this study. Rights for figures from Luppicini and So were acquired from the authors via RightsLink on July 23, 2018, with order number 4395031321751. All FAA and DOT related content is considered government creative works, and as such, “United States government creative works, including writing, images, and computer code, are usually prepared by officers or employees of the United States government as part of their official duties. A government work is generally not subject to copyright in the United States and there is generally no copyright restriction on reproduction, derivative works, distribution, performance, or display of a government work” (U.S. Government, 2018).
Appendix D: Chapter Two Background

This study used classic grounded theory, but started in the first round of analysis with a simple word frequency query. The query looked for any outlying words that may have significant meaning, but none emerged using exact matches, stems, or synonym queries. The most common word was “think”, at just 1.21%, followed by “going”, “just” and “like”. After removing these common and nonrevealing words, the top three words became “FAA”, “people” and “aircraft”, all of which reveal very little if anything at all, with all less than a 1 percent occurrence rate.

The second step used open coding, and looked for themes throughout the interviews that emerged. The list of nodes grew as large as 26 at one stage. Codes were constantly compared and as theories emerged, were analyzed against each interview to see if the construct that developed seemed reasonable. In doing this, this researcher looked for similarities and differences in the codes and those codes seen in each interview, so as to find the core codes categories. When completed, three nodes were identified as core categories: Regulatory, Safety, and Public Perception.
Appendix E: How was the Interviewee Chosen?

Describe the process involved with identifying and contacting the interviewee. What was it about the interviewee that made him/her/they a potential source of valuable research insights?

Interview candidates will be selected based on their reliance on UASs to conduct business or based on a history of involvement with UASs in academia or government. The goal is to interview at least 5 representative experts from each category for analysis and comparison.

Representation from those working in aerial photography, search and rescue, infrastructure maintenance, and the FAA will provide cross-sectional insight. At the end of each interview I will ask for recommendations for other interviewees to limit how my preconceptions of the industry hamper interviewee selection. Interview questions will focus on both the individual’s and their company’s experience with UASs.

Most interviews will be via distance technologies, rather than in-person due to geographical separation and resource availability. Although this diminishes the ability to read non-verbal cues, the study is more rigorous than with just readily available in-person interviews, as it gets the greatest variety of subject matter experts, from the highest levels, from the widest array of geographical locations.
Appendix F: The Interview Questions

If the topic of the interview was motivated by a business question or a research interest, describe the research conducted by the author(s) prior to formulating the questions, including a summary of the findings from any web or library database searches conducted.

Despite this explosion of popularity and the recognition that such systems must find a way to safely operate alongside manned aviation, a literature review by this author as well as preliminary interviews with 3 commercial aerial photography companies in Tampa Bay, Florida, indicated that regulatory restrictions are still the greatest obstacle to law abiding commercial UAS operators. It can take six to eight months with a backlog of 12,000 waiver applications to get either a part 333 or part 107 exemption, which grants FAA permission for a commercial operator to fly a UAS inside controlled airspace (Gardner, 2018). A manned pilot can file a flight plan and hover a helicopter over the same area in just a few hours.

Researchers agree that the level of public opinion and awareness of an issue impacts the issues addressed by legislators (figure 1), but the direction that legislation takes may depend on a number of independent factors that define the regulatory environment which are outside the realm of the issues addressed (Barabas, 2016). During the initial literature review for this study, 738 academic journal references and over 1,500 news articles related to “drone regulations” were uncovered, with only 83 academic journal and 59 news article references occurring prior to 2011.

The significant increase in news articles related to UASs since 2012, and national news coverage such as seen on 28 November 2017 on NBC’s Nightly News, indicate a significant uptick in awareness and
concern (NBC Nightly News, 2017). In addition, the FAA started a national UAS Symposium focusing on UAS regulation in 2016, with the most recent symposium occurring from 6 thru 8 March, 2018, bringing over 950 interested representatives from government, industry, and academia together to tackle the challenge of regulating UASs. This symposium brought together the FAA’s Acting Director, Acting Deputy Director, Acting Director of Flight Standards, Acting Director of Airports, the Executive Assistant of President and Deputy Unmanned Technology Officer, and CEOs from several companies with a significant interest in UASs among others.

It was not the intent of this study to determine actual public awareness and concern, but the increase noted in news articles, the proliferation of UASs, and governmental focus on UAS regulations is determined sufficient for this study’s purpose. With this understanding, the purpose of this research is to determine what industry experts believe the future of UAS regulations hold, and how the industry will be impacted in both the short term of 5 years or less, and long-term of 5 years or more.

During the initial literature review, one article that was itself a literature review by Luppicini and So is of particular influence and importance to this study. It developed a construct of eight categories based solely on articles and news stories related to commercial UASs: safety, ethics and morals, legal, privacy, airspace, information integrity, human versus machine, and commercial related (Luppicini & So, 2016). Figure 2 shows the relative number of references related to each category in graphical form.

The pilot study narrowed these categories down even further, by using a “reflection of the meaning” style, semi-structured interview of three commercial drone operators. The four main categories that emerged are:

- Safety
- Ethics and morals
In the opinion of the business owners interviewed, each of these topics is an issue due to current federal aviation regulations. With this knowledge, this author plans a study designed as a mixed methods / phenomenological study that builds off of these findings, using interviews with leading commercial drone operators, academics, and governmental agencies across the United States as the primary source of information.

Although there is limited academic literature related to UASs and legislation, there is a significant amount of study on the individual topics of stakeholder theory and the impact of regulatory action on business. Stakeholder Theory has evolved significantly since first made common by Freeman in 1984, but his original intent that a stakeholder was “an individual or group of individuals which can affect or be affected by the achievement of organizational objectives” is to be used here and within the study (Freeman, 1984).

Although originally stakeholder theory was discarded by academics who accepted other economic models, the concept of having shared interest in economic activities from various private and public bodies is the determining factor for mentioning this theory. The academic understanding of the relationships cultivated and necessary for business success is still growing, but it is helpful in the relationship to be studied here, to frame the thought in this light:

“while the term “stakeholder” is closely associated with the private sector and corporate world, is is also revealing in terms of the relationship between the business world and public life: it illustrates the difficulty of dissociating various interests, since the environment within which corporations act is not only economic and legal, but also social, political, cultural and ecological.” (Rendtorff & Bonafous-Boucher, 2016).
It is also important to note that the relationship between stakeholders can significantly influence the ability of a technology to evolve and succeed. Since “it is possible for minimum quality standards to stop welfare enhancing innovation”, a budding industry like UASs, that currently uses aviation regulations built to provide extremely high levels of safety in manned aircraft, could be vulnerable to stifled innovation and growth (Blind, S.Petersen, & A.F.Riillo, 2017). Improperly or incompletely designed and implemented regulations related to UASs could seriously undermine industry growth, making this study extremely relevant.

The results of the trial study showed that the largest area of concern for commercial UAS operators is the impact of the current regulatory environment. This study hopes to determine what, if any impediment that regulations are having on UAS operators, and what the perceived direction that regulations will take in the next 5 years. The goal is to then share the results with interested operators, regulatory agencies, and academics. The contrast in opinions should identify the gaps in understanding each side has, thus assisting each stakeholder to better understand the issue so that the most efficient and effective regulations can come about to stimulate the safe and responsible growth of an upcoming and evolving industry.

The first draft of questions included the following, and were broken into the two categories of Business Owners and Regulatory/Governmental:

Business Owners

Q1. How long have you been in your present role with (company), and what role do you play?

Q2. What unique skillsets and experiences you have best prepared you for your current role?

Q3. How long have you used UASs in your company and how would you say they contribute to your ability to conduct business?

Q4. Please tell me about some of your more memorable experiences when using a UAS for your business.

Q5. What would you say was you worst experience when trying to us a UAS and how was is so bad?
Q6. What challenges have you and your company faced when attempting to use UASs?

Q7. How do you see drones helping you and your business in the future?

Q7. Where do you see UASs impacting our daily lives in the United States in the future, and what do you think it will take to get us there?

IF they do not talk about regulations, or if I need to ask more:

Q8. What impact do you see regulations having on UAS operators today?

Q9. What do you think needs to happen to open the most possible airspace to UASs?

Regulatory/Government/Academia

Q1. How long have you been involved in your present role with (agency name), and what role do you play?

Q2. What unique skillsets and experiences you have best prepared you for your current role?

Q3. How would you say you impact, and what are some of the things you are most proud of accomplishing with the UAS Industry?

Q4. Please tell me about one of your most memorable experiences while in this current capacity?

Q5. Where do you see UASs impacting our daily lives in the United States in the future, and what do you think it will take to get us there?

IF they do not talk about regulations, or if I need to ask more:

Q6. What impact do you see regulations having on UAS operators today?

Q7. What do you think needs to happen to open the most possible airspace to UASs?

After doing two test interview, one over the phone and another in person at a UAS conference, the questions were refined to those shown in The Interview section previously, and are also included below:
Q1. How long have you been in your present role with (company), and what role do you play?

Q2. What unique skillsets and experiences you have best prepared you for your current role?

Q3. How long have you used UASs in your company and how would you say they contribute to your ability to conduct business?

Q4. Looking back, is there anything in particular that really sparked your interest in Unmanned Systems, and if so, could you elaborate a bit?

Q5. Where do you see the UAS industry in the next five years, and what kind of things do you see UASs doing as the industry develops?

Q6. What are some of the barriers that you think may currently be, or may in the future impede the ability of the UAS industry to achieve this?

Q7. If you were king for a day, what is the one thing you would change that could enable UAS use to its fullest extent?

Q8. What keeps you up at night?

These questions paired with a minimal number of individual probing questions to stimulate future reflection by the interview subjects gathered the most complete picture of the industry, their subject’s background, and of the issues that they perceived to be slowing the growth of the UAS industry. It allowed the subject to explore a wider variety of potential impediments, and did not press them to highlight the FAA or regulatory challenges unless they perceived it to be a real issue.
Appendix G: The Interview Protocol

Interviewees were contacted either in person, via e-mail, or through LinkedIn chosen based on their perceived expertise and experience in Unmanned Aviation. The attempt was made to select an equal share of interviewees in each of three areas; operations, academic, and regulatory, but as shown earlier in this paper, categorizing interviewees strictly in one of these categories was incomplete and did not truly represent the individuals.

37 experts were asked to participate, not including those for the preliminary interviews, with 14 agreeing to participate in this research. Two interviewees were used to test interview questions and narrow down the list of questions used in the interviews of the other 12. Each interview was recorded using a digital voice recorder, with 11 conducted over the phone and one in-person, which then was transcribed verbatim by Rev.com for analysis.

Each interviewee was interviewed once, with the option of a follow-up interviewee granted by all but not needed. Interviewees were allowed to retract any or all statements at any time, but none requested to do so, and each interviewee was given the opportunity to read the results of the research prior to publication, as well as suggest any edits or deletions.
Appendix H: Subsequent Analysis

Although a thorough literature review was conducted prior to starting this research, as time progressed and interviews were conducted, additional information was either created or discovered that pertained to the topic. Subsequent searching for and reading of this material that included FAA reports, rulemaking documents, daily news stories, and congressional authorization bills continually honed the direction of this study. In most cases, the documents and reports further reinforced the findings, but some of these like the 2018 FAA Reauthorization Bill were found to have the potential to significantly alter the landscape of the industry. If passed, the bill would render parts of this study obsolete as lawmakers address concerns such as privacy and the rights of law enforcement officials to track and respond to errant or unauthorized UAS activity.
Appendix I: Permissions

It was explained to and all interviewees gave their permission for their interviews to be used in this dissertation either in part or in whole. They understood the use was for academic purposes only, and that reasonable care would be taken to distinguish between their personal opinions and their professional responsibilities, and that no attempt would be made to skew the intent of their statements. This consent was granted prior to recording any part of the interview to ensure they fully understood the purpose and use of the results. Drafts of this paper were sent to each interviewee, and they were given 2 weeks to provide feedback and edits. All edits requested were made and are included in this paper.