Unmanned Aircraft System Integration into the United States National Airspace System:

An Assessment of the Impact on Job Creation in the U.S. Aerospace Industry

AUVSI
ASSOCIATION FOR UNMANNED VEHICLE SYSTEMS INTERNATIONAL

Table of Contents

List of Charts

List of Figures

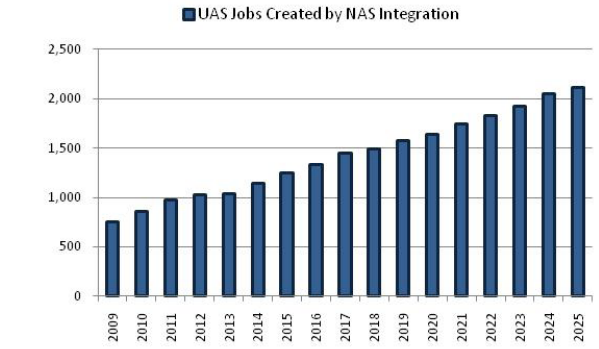
Executive Summary

The U.S. Unmanned Aircraft Systems (UAS) market is a promising segment in the aerospace industry. The Department of Defense (DoD) has successfully deployed unmanned aircraft to war zones around the world. These systems have received widespread attention for their increased use in Iraq and Afghanistan. In addition to military UAS acquisitions and operations, a new UAS sector is being driven by non-military government agencies and commercial entities that are interested in the new technology. This market is small in comparison to the billions of dollars spent annually by the U.S. military for unmanned aircraft, but the potential for future growth of the commercial and civilian UAS space is significant.

This growth, and the positive economic impact it will bring to the aerospace industry, hinges on development in UAS integration efforts into the National Airspace System (NAS). Currently, civilian and commercial organizations interested in operating unmanned aircraft are restricted from doing so due to regulatory barriers. While the Federal Aviation Administration (FAA) has been tasked to begin the process of manned and unmanned aircraft integration via the Unmanned Aircraft Program Office (UAPO) and the issuance of UAS Certificates of Authorization (COAs) and airworthiness certificates, to date UAS integration has been slow. Limited access to airspace is having a negative impact on the unmanned aviation community and many regions of the U.S. that are ready to support UAS industry growth.

AUVSI estimates that over the next 15 years more than 23,000 UAS jobs could be created in the U.S. as the result of UAS integration into the NAS. These new jobs will include positions in industry, academia, federal government agencies and the civilian/commercial UAS end-user community. New UAS-related employment opportunities could translate into more than $1.6 billion in wages over the next 15 years, or $106.6 million annually. Of the new jobs created via increased UAS access to airspace, many positions will be in the manufacturing sector. There will also be positions created for UAS pilots and operators, data analysts, maintenance personnel, and consultants. Universities and colleges are already preparing for the influx of students interested in filling these potential positions. Operator certification and maintenance programs are being created to accommodate students interested in UAS-related career fields. In some cases, four-year professional degrees are being offered.

UAS Jobs Created by NAS Integration



Source: Association for Unmanned Vehicle Systems International

Secondary employment positions will also be created in additional markets affected by the increased demand for UAS. For instance, sensor manufacturers, avionics providers, software developers and composites manufacturers will add manufacturing personnel and engineers to their work forces. Companies will also increase their support staffs by hiring accountants, sales associates, managers, human resources specialists and administrators to ensure business operations run smoothly. Tens of thousands of secondary employment positions could be created as the result of UAS integration into the NAS.

UAS integration will have a tremendous impact on the aerospace industry and aid in driving economic development in many regions across the country. How quickly new job creation and economic benefits become a reality, however, depends on the progress and timeliness of UAS integration efforts. The UAS market is peaking as the result of ongoing operations in Iraq and Afghanistan. Once these deployed systems return home, the UAS industry will be at a crossroads. Access to airspace will be imperative not only to drive new markets and technological developments but also to ensure that the UAS community does not lose experienced personnel. Commercial and civilian operations represent a monumental opportunity for unmanned aircraft manufacturers, components providers, researchers and end users. However, without access to the NAS, the UAS community risks taking a step back and losing the progress it has made in the last decade.

Research Methodology and Scope

Data Collection

This study is comprised of a combination of open source data and primary research interviews. Open source information was obtained via AUVSI UAS industry databases, the Department of Labor Statistics, the FAA, the Government Accountability Office (GAO)

and additional publicly available sources. Primary research was collected via interviews with industry participants, government officials, academia and other key stakeholders in the UAS industry. A select listing of participating organizations has been included in the appendix.

Market Sizing and Forecasts

Market sizing and forecasting estimates were prepared using both historical and current DoD budgetary information, federal contracts and primary information provided by study participants. The base year for the study is 2009 with 2008 data provided in some instances for historical reference. The forecast period is 2010-2025. A 15-year forecast period was selected to display the degree of anticipated change in the commercial and civilian UAS marketplace in 5-year increments.

Research Scope

The study is intended to assess the current state of job growth in the U.S. unmanned aircraft systems market, and make projections on the impact increased UAS operations in the NAS will have on UAS-related job creation. Some overlap between military UAS and civilian/commercial job functions is anticipated. However, information collected as a part of this study indicates that an identifiable percentage of jobs will be created to address UAS operations specific to the civilian and commercial market.

Research Definitions

For the purposes of this study, UAS-related jobs are divided into three categories. A UAS industry job is defined as full-time employment directly supporting the development, manufacture, systems integration or sale of an unmanned aircraft and its key components. These jobs include, but are not limited to, positions such as design engineers, business development staff and airframe manufacturing personnel. A UAS support job is defined as full-time employment supporting UAS operations. These jobs include UAS operators and pilots, mission support staff, instructors, sensor operators and consultants. The last category of UAS jobs includes civilian government personnel and academic positions. These jobs include full-time personnel supporting non-DoD government agencies with their internal UAS programs and college or university-level academic staff supporting specific UAS programs within their respective organizations. U.S. DoD jobs were not included in this analysis.

It is also important to define the difference between the commercial and civilian UAS market. The civilian segment comprises UAS purchases by non-DoD federal agencies such as the Department of Homeland Security (DHS) or the U.S. Forest Service. This segment also includes state and local entities such as state departments of public safety, municipal police departments and fire departments. The commercial market segment includes UAS purchases by non-government organizations. Examples of commercial end users include petroleum companies, real-estate agencies, insurance providers and broadcasting companies.

AUVSI
ASSOCIATION FOR UNMANNED VEHICLE SYSTEMS INTERNATIONAL

1. Introduction

On December 17, 1903, Orville and Wilbur Wright made a controlled, powered and sustained heavier-than-air human flight in what is generally accepted as the first true airplane. The flight lasted 12 seconds, and the aircraft only reached an altitude of 120 feet, but it started a revolution that would change the world forever. In a matter of seconds the dynamics of war, the nature of travel and the transport of goods were altered. The impact of aviation on society has been so significant that we rarely think about flying from Los Angeles to Singapore for a business meeting. Nor do we give much thought to packages delivered in 24 hours from thousands of miles away.

Since 1903 the airplane has been evolving. It has become larger, faster, safer and more technically advanced. In just over a century, aviation has progressed from a 12-second airplane flight to aircraft that can stay aloft for days, jets that surpass speeds of Mach 2 and passenger planes capable of carrying more than 800 travelers at a time. Increasingly, many aircraft are being operated without a pilot or crew onboard. These pilotless planes, also known as unmanned aircraft systems (UAS), are quickly creating an aerospace revolution of their own.

UAS operations have largely been restricted to military missions, but despite the technology's limited customer base the market has rapidly grown in size and the amount of competition. The eventual integration of UAS into the NAS has many positive outcomes for the aviation community beyond driving growth in industry. In a cyclical aerospace environment, unmanned aircraft could be a stabilizing force, unaffected by fluctuating air travel demands and other economic conditions that can send the aerospace industry into a downward spiral.

The UAS market is one sector of the aerospace industry that has not been significantly impacted by the latest economic downturn. In fact, the market for unmanned aircraft has witnessed strong growth since 2004. Growth has been driven by a high demand for UAS to provide intelligence, reconnaissance and surveillance (ISR) and increasingly to perform strike missions in support of ongoing war efforts in Iraq and Afghanistan. Additionally, interest from civilian government agencies and commercial entities indicates that a new UAS market driven by non-military customers is emerging.

In today's economic climate, job creation will continue to be important for the aerospace industry and the U.S. economy. UAS integration into the NAS will fuel job growth by increasing revenue for the industry, spurring increased interest in UAS by the academic community, creating new employment opportunities across the government and commercial customer bases and driving secondary job growth in the UAS subsystems and components markets. Assuming UAS are allowed increased access to airspace over the next 15–20 years, the commercial and civilian operation of unmanned aircraft will have a significant role in spurring future job growth in the aviation sector.

2. UAS: An Important Sector of Aviation

"Persistent flight capability is one of the advantages of employing unmanned aerial vehicles in military missions. What UAS bring to the table is the ability to stay in position or maneuver over large areas for a long period of time - that's where a person in an aircraft becomes a limitation." — Lieutenant General David A. Deptula, USAF, Deputy Chief of Staff for Intelligence, Surveillance, and Reconnaissance

Unmanned aircraft represent a new and uncharted territory for aviation, both militarily and commercially. The systems have been a phenomenal success for the U.S. military and its allies since the onset of the wars in Iraq and Afghanistan. From the 26,700-pound RQ-4 Global Hawk to the 4.2-pound RQ-11 Raven, unmanned aircraft have dramatically changed warfare. The deployment of UAS has not only impacted military airborne operations, they have also introduced a new way of military thinking when it comes to all aspects of warfare in the air, on land or at sea. Ultimately unmanned systems, regardless of where they operate, are assisting soldiers in conducting critical missions around the world.

While interest has been growing in unmanned ground and maritime systems, UAS have received the most funding support to date. This year the UAS industry is expected to set several milestones including the following: In 2010, combined DoD UAS procurement, research and development, and operations and maintenance (O&M) spending will total approximately $3.9 billion; the U.S. Air Force will officially train more UAS pilots than manned fighter and bomber pilots; and the Pentagon, based on budgetary documents, will buy more unmanned aircraft than manned platforms.[1]

Unmanned aircraft are also advancing technologically due to their popularity in theater. As a result of urgent DoD requirements, UAS have been pushed to theater

to provide much needed overhead surveillance to the warfighter. Rapid deployment has allowed industry to benefit from lessons learned in the battlefield. Vast technological improvements have been made not only in terms of UAS airframes but in electro-optical/infrared (EO/IR) sensors, synthetic aperture radar (SAR), navigation systems, communications systems, and command and control (C2) systems as well.

Soldiers, airmen and sailors are benefiting from the advancements in UAS technology. While the Air Force's use of unmanned aircraft is widely publicized it is not the only service benefiting from UAS. The Army, Navy and Marine Corps are all developing, procuring and fielding unmanned aircraft. The Army, in particular, has become a major proponent for the technology. In FY1999, the service flew approximately 13,235 hours with unmanned aircraft. The Army predicts that it will surpass one million UAS flight hours all performed with five different classifications of UAS platforms by April 2010.[2] Eighty-eight percent of the Army's UAS flight hours have been performed in combat. The Navy and Marine Corps are benefiting as well. In a more diversified role, video surveillance provided by an Insitu ScanEagle helped U.S. Navy SEALs rescue cargo ship Captain Richard Phillips from Somali pirates in April 2009. The successful rescue drew media attention around the globe.

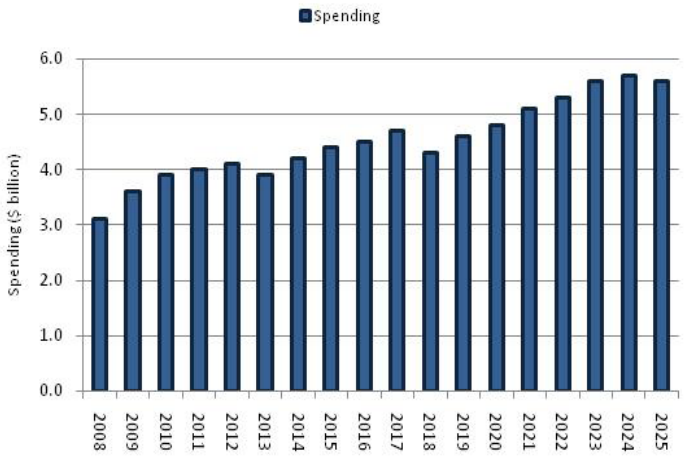
UAS have proven to be indispensible assets for defense and security missions and DoD investment in the technology is increasing. In 2008, combined U.S. DoD spending for UAS totaled $3.1 billion. This number increased to $3.6 billion in 2009 and it is expected to reach $3.9 billion in 2010. The estimated CAGR between 2010 and 2025 for U.S. DoD spending on UAS is 3.1 percent.

UAS popularity does not end with the U.S. military. Armed forces around the globe have taken notice of the technology and are quickly establishing unmanned aircraft fleets of their own. While the U.S. leads the UAS market, comprising 65-70 percent of global spending, we are not the only country developing and fielding the systems. Israeli companies such as Israel Aircraft Industries Ltd. and Elbit Systems Ltd. are established participants in the global UAS market. In Europe, companies including Thales, EADS and QinetiQ are contenders in the global space as well.

The unmanned aircraft industry is facing rapid change driven by high military demand for UAS technologies that are providing new and unrivaled capabilities in the battlefield. In the U.S. and around the globe, new companies are entering the UAS market, and existing companies have diversified their product offerings in an effort to take part in the UAS boom. Since 2003, the number of aircraft in theater has grown exponentially. As a result, the industry has expanded to accommodate increased demand for its products and services. In the U.S. alone, there were more than 300 companies providing unmanned aircraft platforms, subsystems and services in 2009.

Many UAS companies have witnessed impressive job growth as a result of their participation in the UAS industry. AeroVironment, Inc., for example, has witnessed its workforce grow from 495 employees in 2007 to 658 in 2009, with most new employees filling UAS related positions.[3] AeroVironment is not the only company to increase its UAS workforce in recent years. The Insitu Group, now a wholly owned subsidiary of The Boeing Company, employed four people in 2001. Today Insitu maintains a workforce of more than 650 personnel with almost all of these employees supporting the company's UAS products and services.[4]

U.S. DoD UAS Spending Forecast



Source: Association for Unmanned Vehicle Systems International

Chart 2.1
U.S. DoD UAS Spending Forecast: The chart displays U.S. DoD spending on UAS procurement, RDT&E and O&M between 2008 and 2025.

AeroVironment and Insitu are not alone. Companies across the U.S. have experienced growth in their workforces due to direct involvement in the UAS market. These companies manufacture UAS and/or provide support services for unmanned aircraft operations. There are also hundreds of UAS components and subsystem suppliers that have benefited from growth in the industry. They design and manufacture a wide range of products including sensors and payloads, UAS engines and propulsion systems, avionics and composite materials.

Military demand for UAS is also spurring economic development opportunities in many regions of the United States. Grand Forks, North Dakota is one example where unmanned aircraft operations are impacting growth in the community. The University of North Dakota's UAS Center of Excellence, designated by the DoD in 2006, is working to commercialize UAS for a variety of applications in the private sector. Approximately 240 UAS related jobs have been created in the Grand Forks region in the last three years via growth in the UAS industry, and the Grand Forks Economic Development Board expects this number to steadily increase. A UAS business park may be established in the area which could create further employment opportunities in the near-term.

North Dakota is not the only region growing its presence in the UAS community. Several other states are increasing their participation in the UAS sector via local companies and universities. In Ohio, the Dayton Development Coalition (DDC) is working to promote UAS industry growth in the 13-county region it supports. With Wright Patterson Air Force Base nearby and a strong presence in the military UAS community, the DDC feels that Dayton is a prime location to support the broader UAS industry, particularly manufacturing. Similar to many regions of the U.S. that have ambitions of bringing the UAS community to their areas, the DDC has encountered challenges in gaining access to restricted airspace for UAS operations. Access to restricted airspace and/or UAS integration into the NAS will be vital for the DDC and other economic development boards around the country as they attempt to draw UAS companies to their regions.

3. UAS Applications Beyond the Military

The potential for UAS stretches beyond military operations in Iraq and Afghanistan. Unmanned aircraft are being utilized for environmental research in Antarctica, border surveillance in Arizona and damage assessment in Haiti in addition to other non-military missions in the U.S. and abroad.

Border surveillance, disaster response and public safety are the most notable civilian UAS applications to date. Recent natural disasters have drawn attention to the benefits UAS can provide first responders, particularly

Non-Military UAS Successes

1	**Border Surveillance**	In 2009 CBP Predators flew more than 2,000 hours along the U.S. border and contributed to the seizure of more than 12,000 pounds of narcotics.
2	**Arctic Research**	In 2009 the University of Colorado flew an Aerosonde UAS in the Arctic to conduct research on the katabatic winds' relationship to Antarctic sea ice formation.
3	**Fire Response**	In August 2009 the University of Alaska operated a ScanEagle aircraft to map the progression of wildfires in the Alaskan wilderness.
4	**Disaster Response**	A Global Hawk UAS, several Predator systems and a Skylark system provided surveillance for relief efforts following Haiti's devastating earthquake.
5	**Flood Plain Surveillance**	A ScanEagle UAS was utilized in March 2010 by the University of North Dakota to monitor the Red River for flooding following heavy rains in the area.
6	**Wildlife Monitoring**	Throughout 2009 the University of Florida utilized UAS to take aerial photos and monitor wildlife in the Everglades including waterfowl and alligators.
7	**Severe Storm Research**	A team including the University of Colorado is currently conducting research on severe storms and tornadoes using an Aerosonde UAS.
8	**Search and Rescue**	In February 2010 the Mesa County Sheriff's Department in Colorado was granted acccess from the FAA to test a Draganflyer X6 for search and rescue missions.
9	**Auto Accident Investigations**	The Utah Highway Patrol is using photos taken from Leptron UAS to quickly recreate car accidents aiding in the accident investigation process.
10	**Crop Monitoring**	The University of California as well as NASA have been testing UAS in California to monitor the irrigation needs of grape vineyards and pistachio crops.

Figure 3.1
Recent Non-Military UAS Success Stories: The table at right lists ten recent events where UAS were utilized for non-military missions.

Non-Military UAS Applications	
Border Surveillance	Pipe/Power Line Surveillance
Suspect Tracking	Agricultural Applications
Traffic Monitoring	Communications/Broadcast
Disaster Response/Relief	Movie Production
Damage Assessment	Aerial News Coverage
Atmospheric/Weather Research	Mail/Freight Transport
Critical Infrastructure Monitoring	Flood Mapping
Damage Surveying	Real-estate Mapping
Aerial Photography	Mining
Wildlife Monitoring	Sporting Event Coverage

Figure 3.2
Non-Military UAS Applications: The table below provides a listing of non-military UAS applications. In some cases UAS are already being utilized for these purposes on a limited basis.

for search and rescue efforts. Utilizing unmanned aircraft following natural disasters has proven to be a difficult task due to airspace restrictions. However, UAS are playing a minor role in recovery efforts following tornados, floods, earthquakes, and other natural disaster events in the U.S. and other regions of the world. For example, a Global Hawk system provided surveillance over Haiti in the wake of the devastating earthquake in January 2010. Predator and Skylark systems were also operated in the region to aid with the extensive recovery effort.

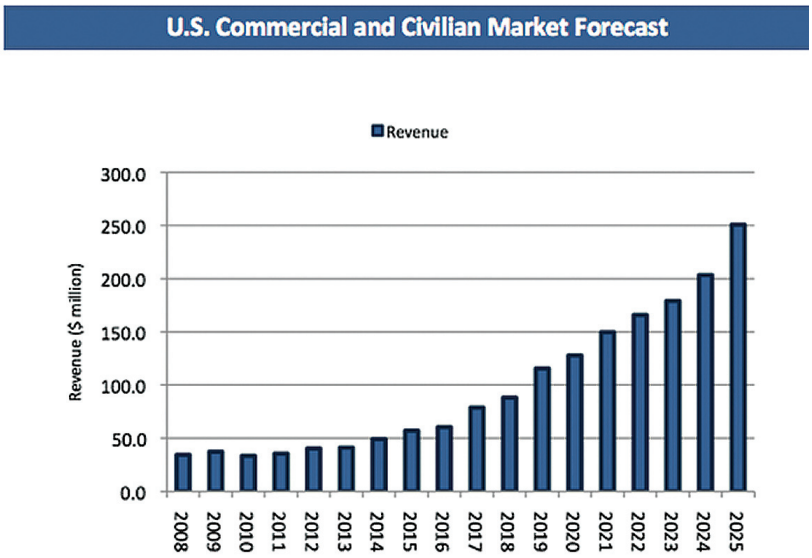
Law enforcement applications for unmanned aircraft have also been emerging. Beginning in the 2006-2007 timeframe, state, local and federal law enforcement agencies started to seriously consider UAS to supplement their current manned aviation assets. Several U.S. police departments have conducted tests with small platforms including Houston and Miami-Dade. Most recently the Mesa County Sheriff's Office in Colorado tested a small UAS for search and rescue missions. As access to airspace issues are resolved, or regulations become more flexible, the law enforcement community could be one of the largest UAS customers following the military.

The impact this will have on the law enforcement community and the UAS industry is substantial. In 2007, there were 941 law enforcement agencies with 100 or more sworn personnel and only 201 of these operated airborne units.[5] Aircraft purchase prices coupled with high operating costs and extensive infrastructure requirements make owning airborne assets unfeasible for many law enforcement agencies. Leaders within these organizations are seeing the value that unmanned aircraft bring to the law enforcement mission, especially for those departments working in rural areas with limited resources and no airborne assets.

Applications beyond disaster response, firefighting and law enforcement are further from becoming a reality. However, if UAS integration issues are resolved, UAS will be employed for a much wider variety of uses than they are today. While surveillance will always be a key UAS capability, in the future unmanned aircraft could transport goods and freight or be utilized as affordable alternatives to satellites by the broadcasting industry.

4. Factors Restraining Market Growth and Job Creation in the UAS Sector

Revenue generation in the commercial and civilian UAS market has been slow. AUVSI estimated that 2009 UAS sales for civilian and commercial applications totaled $37.3 million. A significant portion of this sum financed U.S. Department of Homeland Security (DHS) UAS operations. While a marginal increase is expected in the market over the next 5 years, significant growth will not be realized unless measures are taken to increase airspace access. In an effort to maintain their businesses, many companies have reported that they will be forced to subsidize civilian/commercial UAS activities by attempting to participate in the DoD UAS market since notable growth is not expected in the non-military sector until after 2015. From 2016 to 2025, a moderate increase in growth is anticipated as UAS purchases and support services increase due to more flexibility in airspace restrictions. Systems purchased between now and 2025 will primarily be smaller platforms weighing 20 pounds or less. The use of high-altitude and medium-altitude, long-endurance (HALE and MALE) platforms will be limited to government agencies such as U.S. Customs and Border Protection (CBP) for the next 15-20 years.



Source: Association for Unmanned Vehicle Systems International

Chart 4.1
U.S. Commercial and Civilian UAS Revenue Forecast: The chart displays revenue projections for the U.S. civilian and commercial UAS market between 2008 and 2025.

4.1 Overview of the Challenges Facing UAS Integration

The market for civilian and commercial unmanned aircraft has been slow to emerge due to limited access to airspace. Defining safe UAS operations, setting realistic UAS standards, achieving cultural acceptance and solving radio spectrum challenges are all issues faced by the UAS community and the FAA. For UAS to be integrated into the NAS in a timely manner, and for a positive impact on job growth and economic development to result, these issues need to be addressed.

UAS integration has proven to be a complicated task, and ultimately safety is the primary concern. According to the FAA, the administration supports unmanned aircraft flight activity that can be conducted at an acceptable level of safety.[6] Safety is at the heart of the UAS access to airspace debate. The UAS community does not argue that the first priority for civilian and commercial UAS operations is ensuring that they are always conducted in the safest manner possible. The challenge for the FAA is defining what safe UAS operations entail. Without a definition, the UAS community lacks a clear path forward.

Even when large amounts of time and money have been dedicated to improving the safety of a technology, there is still no guarantee that accidents will not occur. In the automobile industry for example billions of dollars have been invested to make cars safer, but the National Highway Traffic Safety Administration (NHTSA) estimated that 33,963 people died in motor vehicle crashes in 2009.[7] Safety is a key issue for manned aviation as well, but in March 2010 a United Airlines Boeing 777 narrowly missed having a mid-air collision with an Aeronca 11AC. Regardless of the safety systems onboard vehicles and airplanes, accidents are inevitable, and as UAS are granted access to the NAS safety issues will emerge. Similar to the automobile industry, once the safety issues are known, they will be addressed. The automobile, manned aircraft and UAS will never be perfect, but through routine use they will continuously be improved.

Industry is prepared to take the necessary steps to ensure that UAS are safely integrated via the development of sense and avoid (SAA) systems and other technologies. Many participants in the UAS community argue that SAA technologies already exist that would allow UAS to be safely integrated with manned aircraft. To date however, these systems such as ground based radar have not been accepted as viable SAA solutions. To further complicate the integration process, the lack of standards and requirements stretches beyond unmanned aircraft themselves; it is an issue that involves UAS operators and pilots, UAS maintenance personnel, training staff, air traffic controllers and others in the aerospace sector. If the issue of UAS integration were based on technological readiness alone, it could be addressed much easier.

Overcoming the cultural issues associated with UAS operations has also proven to be difficult. There is a public education aspect to UAS integration that has been overlooked. It is important for the general public to understand that unmanned aircraft are not pilotless drones operating without human direction. Unfortunately, UAS are often portrayed by the media as uncontrolled robots stalking targets in the war zone, which can instill fear in the public. In reality, most UAS are small, unarmed systems utilized for surveillance. The UAS community has the responsibility to ensure that the public is educated about the sophistication of unmanned aircraft and the benefits the systems provide.

Another challenge facing UAS integration is lesser known and involves the use of spectrum by unmanned aircraft operating in the NAS. The World Radiocommunication Conference (WRC) has acknowledged the increased interest in UAS operations, and is slowly working to provide support. At the WRC Conference in 2011, a decision is expected to be announced regarding the UAS civil spectrum for UAS C2 systems. Access to spectrum is expected to be an obstacle facing UAS integration that will have to be overcome before large-scale UAS operations in the NAS become a reality.

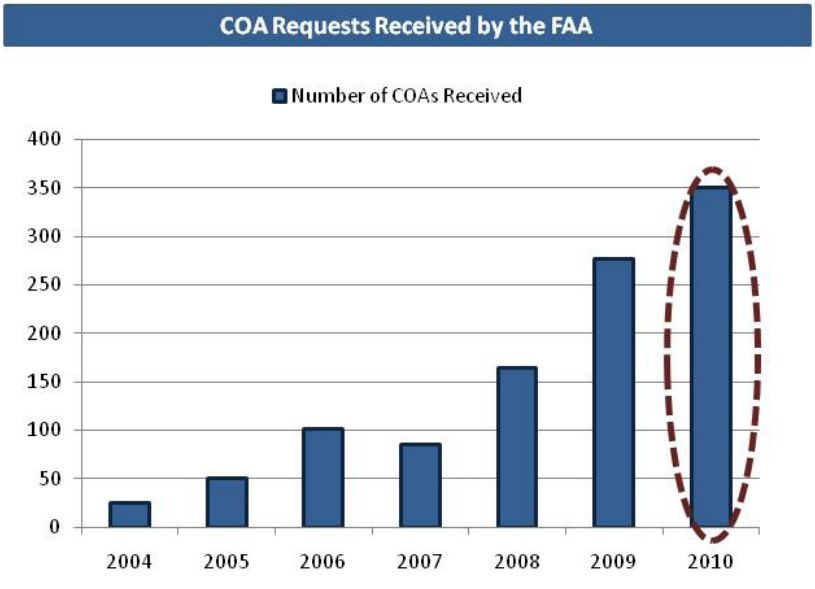
4.2 Recent Efforts to Overcome the Integration Challenges

Efforts to progress UAS integration in the NAS are moving slowly. Many participants in industry, academia and government feel that integration efforts have completely stalled. The long Certificate of Authorization (COA) process, a lack of safety standards or requirements and hesitance to focus on the integration of small unmanned aircraft systems (sUAS) as a first priority are issues creating frustration in the UAS community. There is a general consensus that the UAS integration challenge runs much deeper than the FAA or government. It is a cultural, political and technological challenge that the UAS community as a whole will have to overcome.

The FAA has taken several steps to address the major UAS integration issues, but limited progress has been made to date. The administration created the Unmanned Aircraft Program Office (UAPO), which is intended to establish guidance and certification standards for unmanned aircraft to ensure their safe integration into the NAS. Many in the UAS industry feel that creation of the UAPO was a step in the right direction. In August 2009, the FAA also formed the UAS FAA Industry Team (UFIT) comprised of AAI Corporation, GE Aviation Systems and the administration. UFIT was developed to aid UAS in the NAS flight simulation and testing to assist in flight regulation and standards development.

Additionally, the FAA established the Small UAS Aviation Rulemaking Committee (ARC) that was tasked with reviewing the administration's current sUAS integration approach; conducting a cost-benefit and risk analysis of sUAS integration into the NAS; and establishing working groups to further research, document and make recommendations on the integration issue. Currently, the FAA has set a goal to achieve sUAS integration by the 2012 timeframe, although the UAS community anticipates that this timeline will be stretched. In addition to UFIT and the sUAS ARC, companies across the U.S. are working with the FAA and local government agencies, universities and other potential UAS customers to spread knowledge about unmanned aircraft and the benefits they provide.

While the UAS community will have to work as a team to speed UAS integration efforts, the FAA is positioned to lead the effort. Leading UAS integration into the NAS is a difficult challenge and one that will require adequate resources. For example, the UAPO received approximately 277 COA requests in 2009.[8] The large number of requests has increased the average time it takes to issue a COA from several weeks to a period of months. The extensive waiting period has driven some UAS end users to fly their aircraft without the appropriate certifications. These uncertified operations pose a safety risk and could create additional challenges for the UAS community. With the interest in UAS for public safety and other applications increasing daily, COA applications are expected to increase exponentially. Adequate funding and resources will be needed to address the COA demand and continue the sUAS integration process to



Source: Federal Aviation Administration and the Government Accountability Office

Chart 4.2
COA Requests Received by the FAA, 2004–2010: The chart provides historical data on COAs processed by the FAA. The number of COA submissions for 2010 is an estimate provided by the FAA to the Government Accountability Office.

ensure that at least small unmanned aircraft can be safely and legally integrated into the NAS.

4.3 UAS Integration Timeline

Putting a timeline on UAS integration into the NAS is a difficult challenge due to the issues previously described. The UAS community agrees that UAS integration will happen; however, timeframe estimates vary from respondent to respondent. Perspectives also tend to differ across government, industry and academia. Assuming adequate resources and support are given to drive UAS integration efforts, the following timeline is a realistic roadmap for UAS to gain access to the NAS.

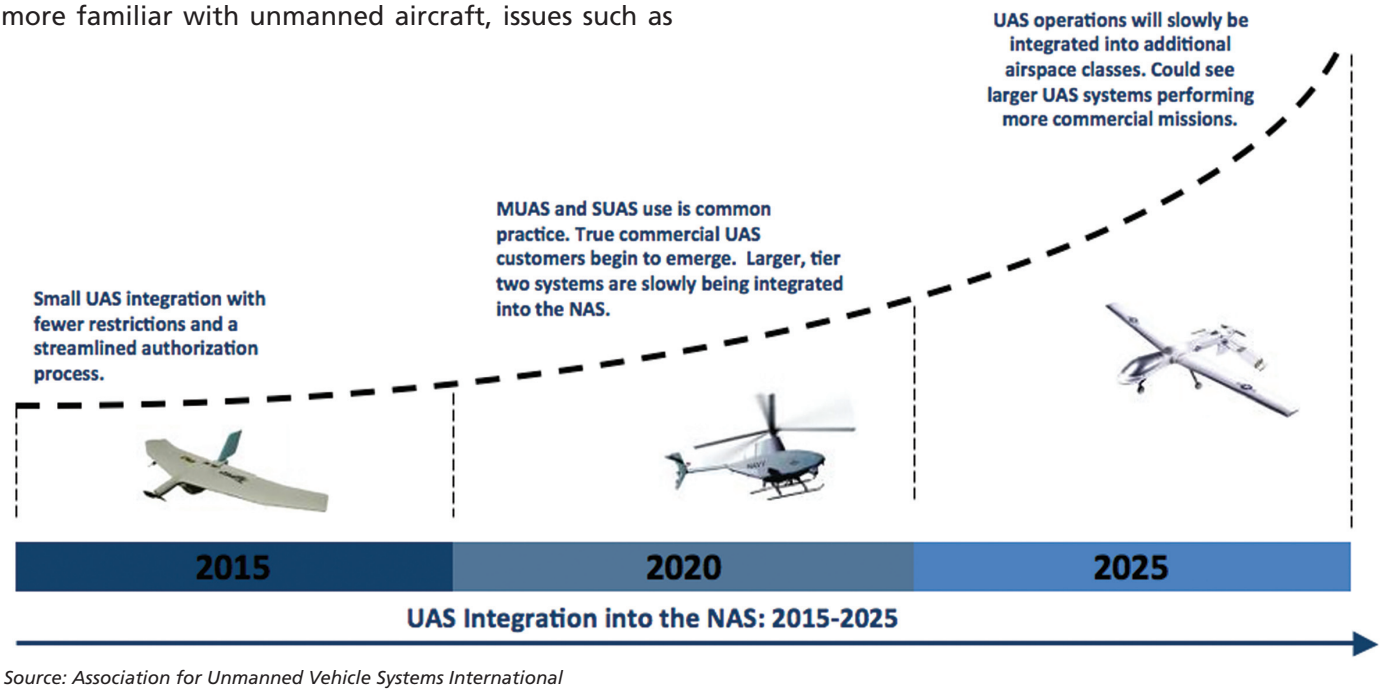
Micro, miniature and small UAS integration efforts are likely to be fully realized by 2015. If the FAA stays committed to the sUAS effort, integration for these platforms could happen as early as 2012. Additionally, the certification process to fly a sUAS will be streamlined and much faster. Systems cleared for public safety applications could be certified and in the air in matter of minutes rather than a period of weeks or months.

The timeline for larger systems to gain increased access to the NAS stretches beyond 2015 and will likely not be realized in this decade unless integration efforts are accelerated. These systems include aircraft weighing more than 55 pounds that operate for hours or days rather than minutes. Commercial UAS customers will also begin to purchase and utilize unmanned aircraft on a larger scale. By 2025, the general public will be more familiar with unmanned aircraft, issues such as insurance and liability coverage will be resolved and UAS operations will be more cost effective than they are today. All of these factors will help to promote the adoption of UAS technology by commercial end users and drive job growth in the aerospace sector.

5. UAS Integration into the NAS: Impact on Job Growth

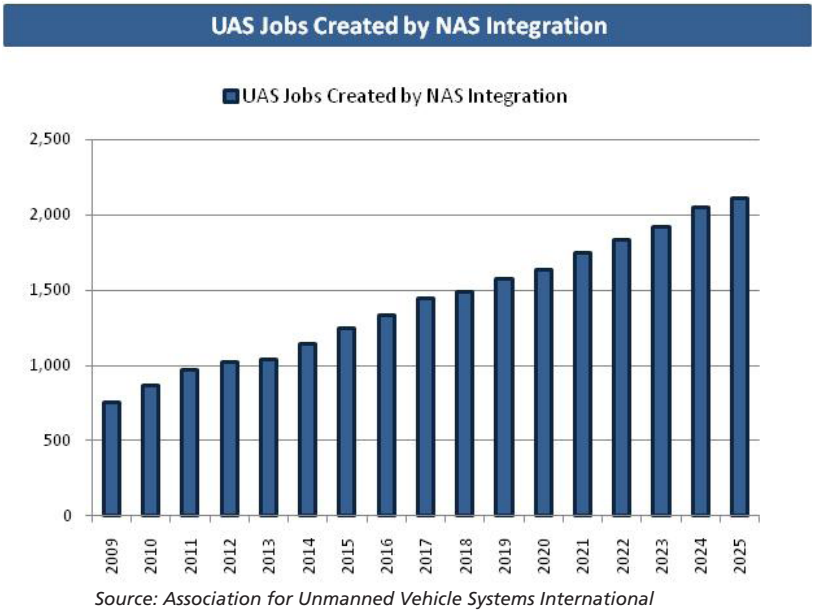
Most companies competing in the U.S. UAS market anticipate that continued DoD purchases and operation of unmanned aircraft alone will drive workforce growth in their organizations at an average rate of 3.5 percent through 2015, then increasing slightly to level out in the 4 to 4.5 percent range through 2025. When compared to the aerospace industry as a whole, this level of growth is notable. Industry has commented, however, that the growth experienced as a result of the military UAS market is miniscule when compared to the potential for the civilian and commercial UAS sectors. Market participants interviewed for this research indicated that the commercial and civilian

Figure 4.1
UAS Integration Timeline: The diagram depicts a proposed timeline for UAS integration into the NAS. The timeline assumes that UAS integration efforts gradually escalate to drive both regulatory change and cultural acceptance of unmanned aircraft.



Source: Association for Unmanned Vehicle Systems International

Chart 5.2
UAS Jobs Created by NAS Integration: The chart displays only job creation via the integration of UAS into the NAS between 2010 and 2025.



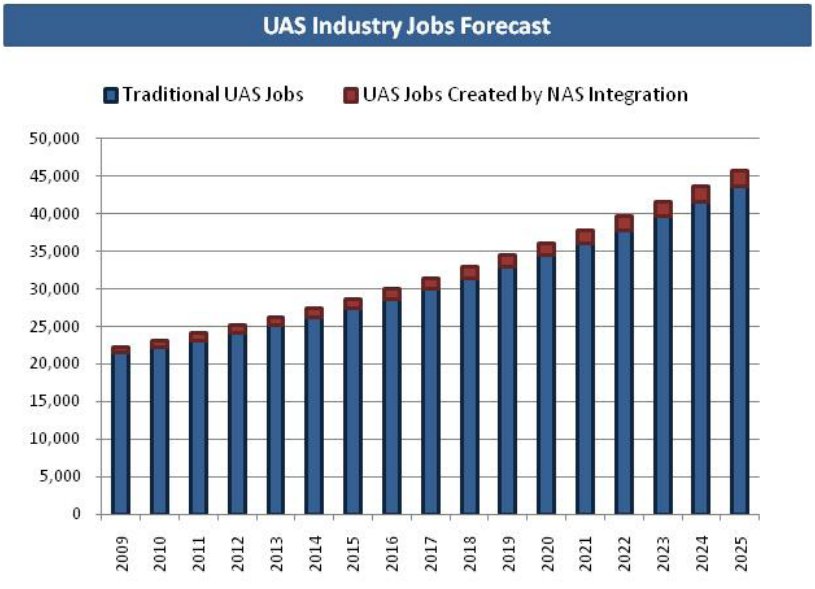
Source: Association for Unmanned Vehicle Systems International

UAS market could be worth significantly more than the current DoD market value if operations in the NAS were a reality. This increase in UAS market size would have a significant impact on companies participating in the UAS platforms and services market, which would in turn drive growth throughout the secondary UAS markets. Assuming that integration efforts progress as outlined in the timeline, we can expect the following impact from UAS driven job creation.

5.1 Job Growth Projections

Between 2010 and 2025, more than 23,000 UAS jobs could be created by the integration of unmanned aircraft into the NAS, assuming integration follows the timeline depicted in Figure 4.1. AUVSI's analysis of current UAS integration efforts indicates that the economic impact driven by UAS integration into the NAS will be progressive, much like UAS integration itself. Due to ongoing access to airspace issues, there will be little change in the UAS workforce between 2010 and 2015. The increase in UAS jobs during that timeframe will directly correspond with the strength of DoD spending on UAS technology. After 2015, the civilian and commercial market for UAS will gain momentum, spurring growth in organizations that manufacture small unmanned aircraft and/or provide UAS leasing services. Beyond 2020, UAS companies will begin to augment their workforces to accommodate the surge in unmanned aircraft demand primarily from local, state and federal government agencies and to support increasing interest from commercial entities as well.

The job creation forecast outlined below assumes a slow, but progressive UAS integration process. It is important to note that if all classifications of



Source: Association for Unmanned Vehicle Systems International

Chart 5.1
UAS Industry Jobs Forecast: The chart displays projected U.S. job growth between 2010 and 2025 based on growth projections for the UAS market. In this chart traditional UAS jobs marked in blue reflect the current UAS job market. Without UAS integration into the NAS there will still be some job growth as reflected in this chart. For example, AeroVironment will continue to increase its workforce to support DoD demand for its UAS products over the forecast period. UAS jobs created via NAS integration marked in red reflect new jobs driven specifically by the increased use of unmanned aircraft for civilian and commercial applications in the national airspace system.

UAS were allowed access into the NAS by the end of 2010, the economic impact and number of jobs created would be much more substantial. On the other hand, if UAS integration efforts completely stall in 2010, the opportunity for the creation of more than 6,000 jobs could be lost over the next 5 years. These numbers may not appear significant when compared to the overall aerospace workforce, but they are incredibly important for the UAS community. And, while the UAS industry only comprises a small piece of the aerospace sector, it is driving the next evolution in aviation.

5.2 Job Growth in the Primary UAS Market

Between 2010 and 2025 the UAS industry will experience the most job growth as the result of unmanned aircraft integration into the NAS. Specifically, companies manufacturing sUAS, offering unmanned aircraft leasing services and/or those providing UAS services such as training and consulting will see increased growth in their organizations.

Tier 1 defense contractors competing in the UAS space will witness workforce growth as well, but a considerably larger percentage of their growth will continue to be driven by their participation in DoD UAS programs. For instance, Northrop Grumman could have fewer civilian and commercial opportunities for its Global Hawk UAS between 2010 and 2025 due to the size, cost and logistical issues associated with the aircraft.

Initially, UAS jobs created by the end-user community will be slow. Potential UAS customers such as police and fire departments, ranchers and farmers, petroleum companies and many other entities may not benefit from owning and operating their own unmanned aircraft. Instead, these end users will lease systems from UAS service providers. Leasing will be an integral part of civilian and commercial UAS adoption that will allow end users to benefit from and be educated on the technology without assuming the risk of ownership. There are several companies in the U.S. already providing leasing services, including The Insitu Group and Evergreen Unmanned Systems. As the civilian and commercial market emerges, there will be an influx of companies offering UAS for hire. Many existing UAS companies will adopt the business model and new market participants will surface, providing UAS operations on a low cost, low risk basis.

Federal, state and local jobs will also be created through UAS integration. Many government agencies such as CBP, NOAA, the U.S. Geological Survey (USGS) and even state departments of public safety already have UAS programs in place with dedicated workers supporting unmanned aircraft missions. As these entities increase UAS operations they will increase their workforces. Increased UAS operations in the NAS will also require more airspace support personnel such as air traffic controllers and regulatory professionals employed by the federal government.

The academic community will be impacted on a smaller scale. Several universities have developed curricula, certification courses and four-year degree programs to accommodate students interested in becoming UAS pilots and sensor operators. Currently, many civilian UAS operators support the DoD, working for both large and small defense companies. The majority of these contractors received their UAS training while serving in the military. As commercial UAS operations increase, interest in the technology by high school and college students as well as individuals without military backgrounds will grow as well. This will drive colleges, universities and technical institutes to add UAS programs to their degree and certification offerings, which will create both faculty and administrator positions.

5.3 Job Growth in the Secondary Market and Indirect Employment Opportunities

The economic impact of UAS integration will not stop with the primary UAS market. Similar to other industries, job growth will stretch into many additional sectors. The aerospace industry, for example, reaches far beyond airplane manufacturers and the airlines in terms of economic impact. When the civil aerospace industry is in a decline, hotels, restaurants and taxi drivers are affected. Alternatively, when air travel demand is high, the hospitality and entertainment industries thrive. The health of the aerospace industry is directly linked to the growth or decline of businesses across multiple U.S. industries.

On a smaller scale, this phenomenon is true for the UAS sector. Economic growth in the primary UAS market segment will have an impact on the secondary UAS components and subsystems markets. This sector is comprised of the subsystem providers that manufacture UAS autopilots, navigation systems, engines, embedded computing technologies, software, thermal imagers, cameras, radar systems, composites, sensors and many

other components and materials used to create a UAS. As the demand for UAS increases, so will the demand for all of the pieces and parts that make up the system. This will drive growth for companies participating in many secondary UAS markets.

Employment opportunities will also be created that have no connection to the manufacture, operation or sales of UAS airframes, subsystems or components. These job positions will be created indirectly by UAS integration into the NAS and will include accountants, human resources specialists, information technology personnel, administrators, managers, advertisers, public relations specialists and all the other support personnel required to successfully run a business. UAS industry growth driven by increased marketplace demand has the potential to dramatically impact job growth across multiple industries, providing employment opportunities to a variety of professionals.

5.4 Job Creation Overview

The types of jobs created by UAS integration into the NAS will be vast. Some jobs will be professional, technical positions requiring a four year degree from an accredited college or university. Others may require military experience. Some positions will be created for UAS pilots, sensor operators, engineers and maintenance personnel. Many more employment opportunities will be manufacturing related. Initially, potential civilian and commercial UAS customers may have limited knowledge and experience working with UAS technologies. As a result, strong demand is expected for UAS consultants responsible for assisting customers unfamiliar with unmanned aircraft technologies and operations. Additionally, as UAS are increasingly operated in unrestricted airspace, there will be demand for analysts. UAS operations in the military produce hours of full-motion video in a single mission requiring dedicated personnel to sift through the data. Whether an unmanned aircraft is being used for wildland fire tracking or crop monitoring, personnel will be required to analyze and interpret the information collected by the system.

UAS Job Salary Information

Position	Annual Salary Range
UAS Pilot	$85,000–$115,000
Systems Engineer	$72,350–$127,000
Instructor/Training Specialist	$74,500–$93,000
Intel/Imagery Analyst	$57,350–$84,600
Maintenance Specialist	$59,500–$67,500
Sensor/Payload Operator	$69,300–$89,450
Manufacturing	$45,700–$67,890
Consultant	$70,500–$145,000

5.5. Why Must UAS Integration into the NAS Succeed?

The economic impact analysis outlined in this report assumes a steady progression in UAS access to unrestricted airspace. If UAS integration efforts result in the uninhibited operation of all classes of UAS in the NAS over the next 5 years, positive economic benefits will result and UAS employment opportunities will develop sooner than expected. Alternatively, if efforts to integrate UAS into the NAS are stalled, serious repercussions will result, including

Figure 5.1
UAS Job Salary Information: The table displays the top 8 UAS-related jobs with corresponding average annual salaries for each. Jobs are not listed in any particular order. Salaries can vary greatly depending on the job candidate's level of experience, the state in which the job is located, the size of the company providing the position and whether the opportunity is in the private or public sector. Average salaries were derived based on study interviews, UAS related job solicitations and annual aerospace salary information published by the U.S. Department of Labor Statistics.

the following: Smaller, UAS-centric companies will struggle to stay in business; end users, especially those in the public safety field, will miss the opportunity to employ a technology with proven life-saving benefits; the military will be challenged to maintain the readiness levels of UAS operators; the U.S. will risk being surpassed in the global UAS space in terms of technology development; and the U.S. aerospace industry will miss an opportunity for economic growth at a time when many sectors are declining. New job growth will be stifled and current jobs in the UAS industry could be lost. The repercussions associated with failed UAS integration efforts will negatively impact the UAS community for years to come.

Smaller companies competing in the UAS market are counting on UAS access to airspace to maintain their businesses. Some are lesser known participants in the UAS industry but the roles they play in terms of driving knowledge about UAS operations in their local communities are very important. DoD contracts help the companies to stay in business but winning contracts is not always a reliable stream of revenue. The future of these companies hinges on UAS access to airspace, especially for sUAS. These market participants could witness significant growth by increasing their customer bases beyond the military.

The public safety community wants to use sUAS platforms to support a variety of missions but airspace restrictions have limited their ability to do so. Police officers, firefighters and others in the public safety field recognize that UAS platforms not only offer increased protection through improved situational awareness, but they also offer cost savings versus deploying a manned helicopter. Despite the life-saving benefits UAS can provide, only a small number of law enforcement and public safety organizations are currently using the technology due to time requirements associated with the COA process.

The DoD has a vested interest in UAS operations in the NAS as well. Since 2003 the military has been operating UAS in Iraq and Afghanistan to support the war efforts. These operations have provided the services with invaluable experience using the systems. Unmanned aircraft will eventually be returning to the U.S. from the war zone creating challenges for UAS training, testing and evaluation and UAS technology advancement. The DoD recognizes the importance of unmanned aircraft operations in the NAS and is actively working to ensure that military UAS systems have increased access to maintain operator and crew readiness, in addition to aiding civil authorities when needed.

While the U.S. leads the global unmanned aircraft market today, other countries with more flexible airspace regulations are quickly increasing their participation in the UAS sector. In some cases companies are not waiting for integration issues to be resolved. In Canada, for example, a firm frustrated with limited access to airspace moved its operations to Australia where sUAS platforms are allowed to fly at low altitudes.[9] The U.S. cannot afford to lose any UAS companies that are driving innovation in unmanned aircraft technology.

Finally, assuming there is no change in UAS access to airspace restrictions over the next 15 years, the aerospace industry stands to lose approximately $1.6 billion in UAS job wages. That averages $106.6 million in lost wages annually. Every year that UAS integration into the NAS is delayed, the industry will feel the negative impact both technologically and economically. UAS companies with limited exposure to the DoD are already struggling to find capital, and regions of the U.S. that could be UAS manufacturing and research and development centers are being stifled. The UAS community is relying on the progress of UAS integration efforts to attract investors, promote a young generation of aerospace talent and drive the advancement of UAS technology.

6. Conclusions

In just over 100 years, aviation evolved from a 12-second flight to an industry that impacts almost every U.S. household and business. Today civil aviation represents a multi-billion dollar industry that employs hundreds of thousands of U.S. workers across the country. Aviation is evolving once again as the military and civilian public invent new and innovative ways to benefit from unmanned aircraft. While the UAS sector of the overall aerospace industry is small today, the integration of unmanned aircraft into the NAS will have a tremendous impact on the sector's future growth.

Integration will drive significant job growth for the unmanned aviation community across industry, government and academia. In the UAS sector, the

types of jobs that will be created are vast and include engineering positions, operators, consultants and analysts. While these jobs vary drastically in the skill sets they will require, they all offer high annual salaries and wage rates. As the higher education community begins implementing UAS related curricula, a young generation of aerospace engineers will emerge attracted by their interest in unmanned aviation and the promise of high paying employment opportunities after graduating.

A significant number of manufacturing positions will also be created via growth in the civilian and commercial UAS market. These positions will include UAS airframe manufacturing but will also span across secondary markets including areas such as electronics and composites. Support positions will also be created across both the primary UAS market and the secondary subsystems and components markets. Managers, accountants, advertising personnel and administrators will be required to support growing businesses providing UAS airframes, subsystems, components and services.

Despite the positive economic impact that would result by UAS operations in the NAS, integration efforts will be stifled and could potentially fail if progress is not made quickly. Appropriate resources and funding must be provided to ensure that COAs are issued in a timely manner, sUAS integration efforts can be carried out as a first priority and UAS technology requirements such as SAA can be addressed.

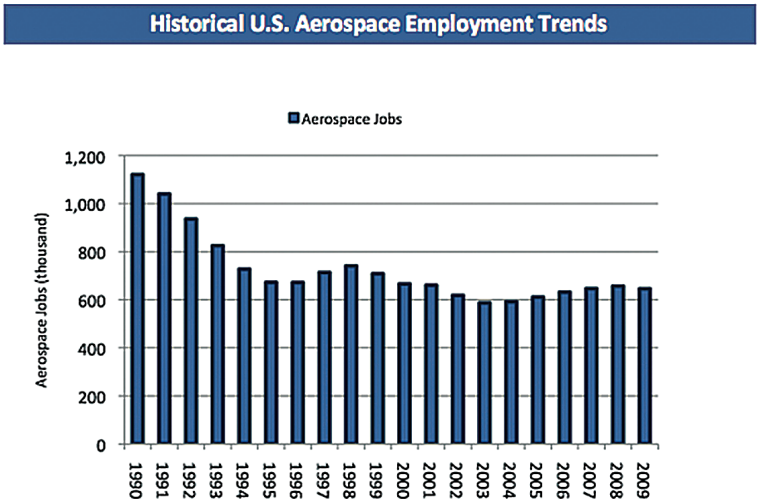
UAS integration is not entirely a governmental, political or FAA issue. The UAS community has the responsibility to join in the effort to educate the public and the potential civilian and commercial customer base on the benefits of unmanned aircraft. Exciting a young generation of pilots and engineers will also be crucial. As a result, collaboration between industry, government and academia will be increasingly important. Ensuring that unmanned aircraft are integrated and safely operated in the NAS will be a UAS community effort. With the appropriate support, resources, funding and implementation of realistic UAS requirements, the successful integration of unmanned aircraft into the NAS will become a reality, and UAS job growth driven by a thriving UAS market will be achieved.

AUVSI
ASSOCIATION FOR UNMANNED VEHICLE SYSTEMS INTERNATIONAL

7. Appendix

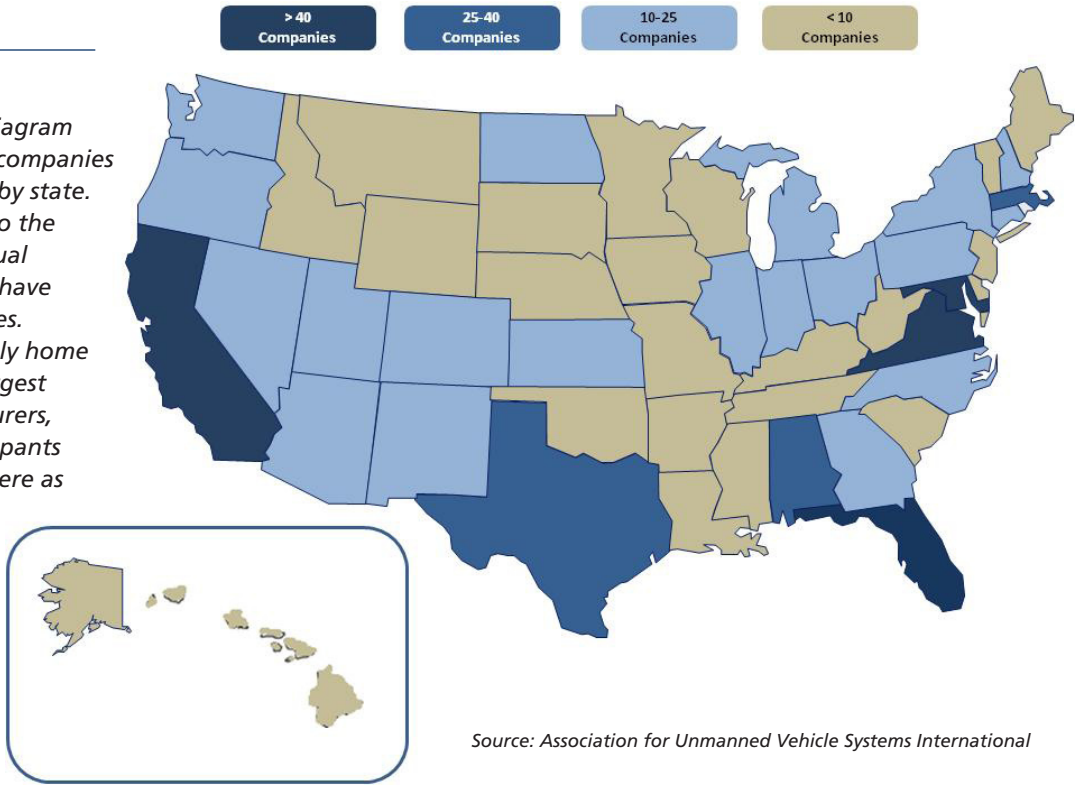
7.1 Supporting Information

Chart 7.1
Historical U.S. Aerospace Employment Trends: The chart displays the cyclical nature of the U.S. aerospace job market. Job functions in this analysis include manufacturing and related employment for the following: airframes, engines and engine parts, aircraft parts and equipment, space vehicles and search, detection and navigation equipment.[10]



Source: Aerospace Industries Association

Figure 7.1
UAS Companies per State: The diagram shows the estimated number of companies participating in the UAS market by state. The delay of UAS integration into the NAS will not only impact individual companies and cities; it will also have a large impact on state economies. California, for instance, is not only home to some of the UAS industry's largest and most well-known manufacturers, many smaller UAS market participants and suppliers have a presence there as well. California will benefit significantly from UAS integration, but if efforts are hindered, it will miss an opportunity for economic growth.



Source: Association for Unmanned Vehicle Systems International

Appendix

7.2 List of Acronyms

- **ARC** Aviation Rulemaking Committee
- **AUVSI** Association for Unmanned Vehicle Systems International
- **C2** Command and Control
- **CAGR** Compound Annual Growth Rate
- **CBP** U.S. Customs and Border Protection
- **COA** Certificate of Authorization
- **DDC** Dayton Development Coalition
- **DHS** Department of Homeland Security
- **DoD** Department of Defense
- **EO/IR** Electro-Optical/Infrared
- **FAA** Federal Aviation Administration
- **GAO** Government Accountability Office
- **GPS** Global Positioning System
- **HALE** High Altitude Long Endurance
- **ISR** Intelligence, Surveillance, Reconnaissance
- **MALE** Medium Altitude Long Endurance
- **MUAS** Micro Unmanned Aircraft System
- **NAS** National Airspace System
- **NASA** National Aeronautics and Space Administration
- **NHTSA** National Highway Traffic Safety Administration
- **NOAA** National Oceanic and Atmospheric Administration
- **O&M** Operations and Maintenance
- **RDT&E** Research, Development, Testing and Evaluation
- **SAA** Sense and Avoid
- **SAR** Synthetic Aperture Radar
- **sUAS** Small Unmanned Aircraft System
- **UAPO** Unmanned Aircraft Program Office
- **UAS** Unmanned Aircraft System
- **UFIT** UAS FAA Industry Team
- **USGS** U.S. Geological Survey
- **WRC** World Radio Communications

7.3 Select Listing of Research Participants

- **AAI Corporation**
- **Aerodyne, Inc.**
- **AeroVironment, Inc.**
- **Cole Engineering Services, Inc.**
- **Defense Research Associates**
- **Dayton Development Coalition**
- **Battlespace, Inc.**
- **BOSH Global Services**
- **Embry-Riddle Aeronautical University**
- **Evergreen Unmanned Systems**
- **Flint Hills Solutions**
- **Foliage**
- **The Green Tree Group**
- **Heartland Defense Industries, LLC.**
- **Institute for Development Commercialization of Advanced Sensor Technology (IDCAST)**
- **L-3 Communications**
- **Mesa County Sheriff's Department**
- **NASA Ames Research Center**
- **NASA Langley Research Center**
- **NASA Goddard Space Flight Center**
- **UAV Collaborative**
- **University of North Dakota – UAS Center of Excellence**
- **U.S. Geological Survey**
- **Wyle**

8. References

[1] Pincus, W. (2009, August 11) Air Force Training More Pilots for Drones than for Manned Planes. *The Washington Post*. Available at http://www.washingtonpost.com/wp-dyn/content/article/2009/08/10/AR2009081002712.html

[2] Colonel Gonzalez, Gregory B. (2010) *Government Program Manager Perspectives Panel* [Power Point slides]. Available at http://www.auvsi.org/AUVSI/Community/Resources/LibraryDocuments/Default.aspx?LibraryKey=ee803e2d-ae2f-456e-bdcd-eb624ed43d75

[3] AeroVironment, Inc. (2009). *2009 Annual Report*. Available at http://investor.avinc.com/annuals.cfm

[4] Green, S. (2009, July 9) In Remote Washington, Insitu's Growth takes Off with Remote Aircraft, *The Oregonian*. Available at http://www.oregonlive.com/news/index.ssf/2009/07/insitus_growth_takes_off.html

[5] Department of Justice. Bureau of Justice Statistics. (2007). Aviation Units in Large Law Enforcement Agencies, 2007. Available at http://bjs.ojp.usdoj.gov/content/pub/pdf/aullea07.pdf

[6] Federal Aviation Administration. (2007). *Unmanned aircraft Operations in the National Airspace System*. (FAA-2006-25714). Washington, DC. Available at http://www.faa.gov/regulations_policies/significant_documents/index.cfm?documentID=21998&documentTypeID=0&fuseAction=c.dspDocumentInformation

[7] Department of Transportation. National Highway Traffic Safety Administration. NHTSA National Center for Statistics and Analysis. (2010). Early Estimate of Motor Vehicle Traffic Fatalities in 2009. (DOT HS 811 291). Washington, DC. Available at http://www-nrd.nhtsa.dot.gov/Pubs/811291.pdf

[8] FAA Fact Sheet. Retrieved April 6, 2010 from the Federal Aviation Administration website: http://www.faa.gov/news/fact_sheets/news_story.cfm?newsid=6287

[9] Pugliese, C. (2009, November 16) Small Unmanned Aircraft Can't Fly Through Red Tape, *Canwest News Service*. Available at http://www.nationalpost.com/story.html?id=2226289

[10] Aerospace Industries Association. (2010). Total Employment: Annual Calendar Years 1990-2009. Available at AIA website: http://www.aia-aerospace.org/assets/stat12.pdf

AUVSI

ASSOCIATION FOR UNMANNED
VEHICLE SYSTEMS INTERNATIONAL