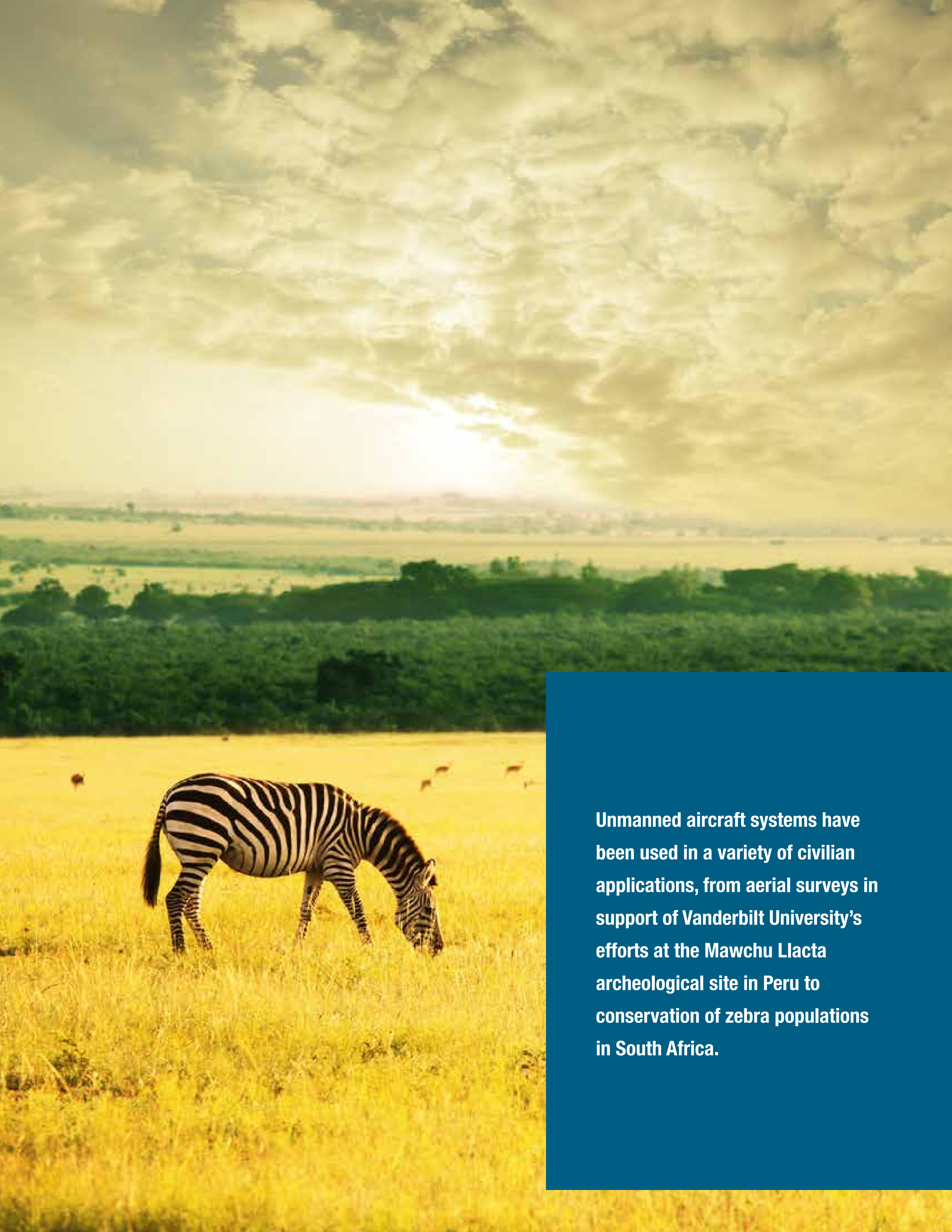
AEROSPACE INDUSTRIES ASSOCIATION

Unmanned Aircraft Systems: PERCEPTIONS & POTENTIAL



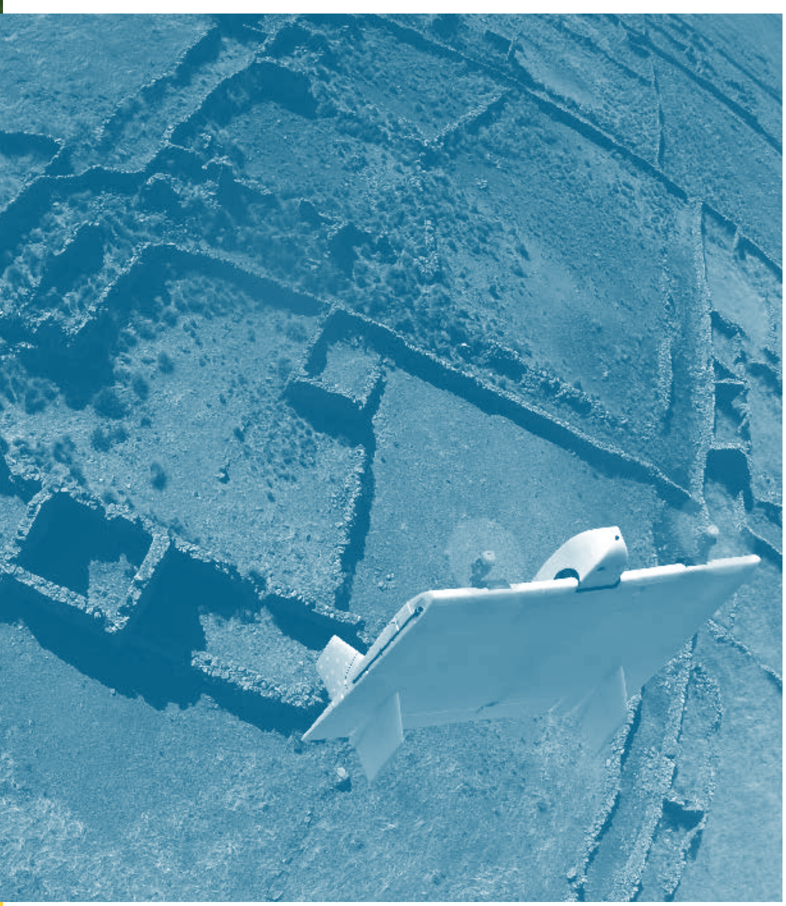
Unmanned aircraft systems have been used in a variety of civilian applications, from aerial surveys in support of Vanderbilt University's efforts at the Mawchu Llacta archeological site in Peru to conservation of zebra populations in South Africa.

Introduction

While unmanned aircraft systems (UAS) have been used for decades, they are increasing in number and effectiveness as aircraft, sensor and automation technologies mature.

Consequently, the potential benefits of these systems are now projected to extend well beyond military use – to a variety of domestic applications that will improve the safety of our communities, strengthen public services and achieve countless additional benefits to a wide variety of commercial and government organizations.[1]

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



As a growing activist community responds to frequent headlines about the military use of unmanned aerial vehicles (UAVs) – the flying component of an unmanned aircraft system[2] – there has been little acknowledgment of UAV use for humanitarian, disaster response, search and rescue, and other life-saving applications. At the same time, the debate over military use is often distinctly one-sided, with a bias against discussion of the ways in which UAVs protect the lives of American servicemen and women, and a lack of distinction between remotely piloted aircraft systems and "fire and forget" missile and munitions technologies.

These and other perception issues are often applied to aerial platforms, while the benefits of their technological brethren in ground- and sea-based systems go largely unquestioned.[3] Unmanned underwater vehicles were used in repair operations following the 2010 Gulf of Mexico oil spill, sparking scant controversy.

Following the Boston Marathon attacks, there was also little debate regarding the use of robotics to explore the location of an alleged bombing suspect, given the obvious need to protect law enforcement personnel. Very seldom does the rationale of protecting human lives extend to the use of aerial systems. This must change.

Regardless of the policy and public perception issues that present obstacles to UAS growth, federal agencies and the U.S. aerospace industrial base are addressing the regulatory and technological hurdles to their widespread use.

The obstacles are significant, however, and many remain unresolved. Failure to implement effective policies regarding spectrum allocation, airspace and certification regulations and export controls will severely limit the UAS sector, which could otherwise grow to become an $89 billion market in the next decade.

This report attempts both to define unmanned systems properly and to demystify their applications. It also explores the societal benefits presented by their domestic use, and the policy priorities that must be addressed in order to keep the United States in its leading position in global UAS technology.

Unmanned Systems: On the Ground, Underwater and Overhead

Ground Systems

Unmanned systems have been used by the U.S. military and domestic law enforcement agencies for decades. Many of the most common unmanned vehicles are robotics systems used by explosive ordnance disposal (EOD) teams – or bomb squads – to examine or contain dangerous or suspicious objects.

These ground systems are credited with saving countless lives, and their use is growing. In military areas of operation, they are widely used to counter the threat from improvised explosive devices (IEDs). Thousands of these ground systems have been deployed in Afghanistan and Iraq. Like their deployment by civilian bomb squads on U.S. soil, counter-explosive robots are seen as vital to keeping personnel out of harm's way while EOD professionals remove threats capable of inflicting widespread casualties, either among civilian populations or allied combatants.[4]

"The cost of losing a robot is not nearly as [high] as losing a trained EOD person. Time on target is our biggest danger, and these robots eliminate us from having to go downrange if we don't have to."

- Sgt. 1st Class Gregory Carroll, 184th Ordnance Battalion, U.S. Army[4]

Maritime Systems

Unmanned maritime systems, called autonomous underwater vehicles (AUVs) or unmanned surface vehicles (USVs), have been deployed for a variety of military, government and commercial applications.

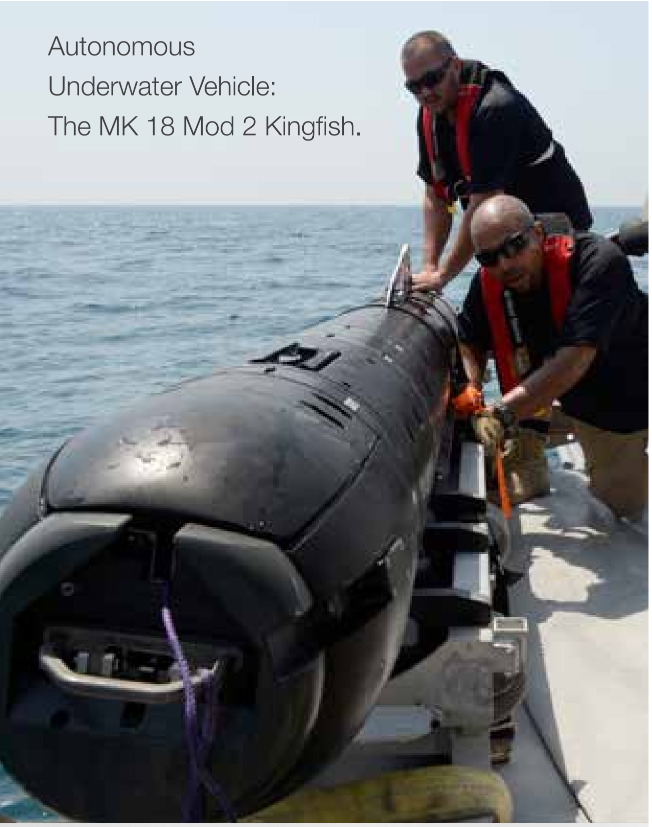
AUVs are used for minesweeping operations by the U.S. Navy. Among these are the MK 18 underwater vehicle – a remotely piloted, torpedo-shaped vessel that searches for and identifies mines. The MK18 was one of several systems deployed in minesweeping operations off the coast of Iran in 2012. Another technology at use in the Persian Gulf is the SeaFox, an expendable underwater system that can approach a mine and detonate it safely.[5]

Commercial AUV platforms include minisubs called remotely operated vehicles (ROVs). Following the 2010 Gulf oil spill, these subs were sent a mile below the ocean's surface to cut off oil flowing from the damaged BP Deepwater Horizon rig. Ship-based operators used ROVs to cut pipe, unbolt equipment, attach hoses and sensors, take high-definition video and attempt to activate the Horizon's cutoff valve.[6]

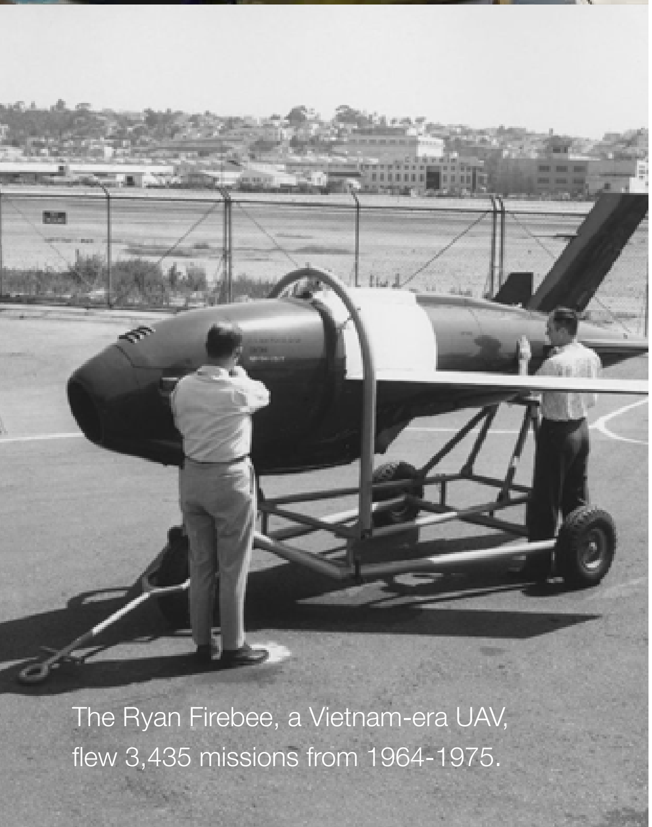
Other commercial applications of AUVs include underwater mapping, surveying and salvage. AUVs are used by oil and gas companies to determine pipeline and oil exploration sites that will have the least amount of environmental impact. Scientists used AUV systems to locate and image the sunken Titanic, and also deploy AUVs to study lakes and oceans, using a variety of sensors. In 2009, an AUV gave scientists their first prolonged look at Challenger Deep, the deepest known point of the Earth's seafloor, in a section of the Mariana Trench that is more than 35,700 feet below the surface of the Pacific Ocean.[7]

USVs are used in oceanographic research, generating data on sea life and water quality, and have been used for pollutant tracking, surveillance and mapping.

Aerial Systems



Autonomous Underwater Vehicle: The MK 18 Mod 2 Kingfish.



The Ryan Firebee, a Vietnam-era UAV, flew 3,435 missions from 1964-1975.

Despite widespread use and high public visibility, ground and maritime systems have generated far less public policy debate than unmanned aircraft systems, which also have been deployed for the same life-saving purposes, and often where the mission for manned vehicles may be too “dirty, dull or dangerous.”

Defined by the U.S. Department of Defense as “an aircraft or balloon that does not carry a human operator and is capable of flight under remote control or autonomous programming,”[8] unmanned systems have been in use by American armed forces since 1917, when the Kettering Aerial Torpedo flew using preset pneumatic and electrical controls. Radio control technology enabled the use of pilotless flight in both world wars on a limited basis, and improvements in altimeter, gyrocompass and guidance technology led to increasing deployments during the Vietnam era. From 1964 to 1975, the U.S. Air Force flew 3,435 reconnaissance drone missions over North Vietnam and its surrounding areas, and lost 554 UAVs during the conflict.[9]

With the advent of GPS technology, stealth-based three-dimensional thrust vectoring flight control [jet steering], and advanced avionics, UAS entered the modern age in the late 1980s, when they were effectively deployed for reconnaissance by the Israeli Air Force, and later by the United States in the Balkans.

In 1999, the United States flew 100,000 flight hours with unmanned systems. Today, the United States flies more than 1 million unmanned flight hours annually, and the Department of Defense operates more than 7,000 UAS.

The growth of unmanned systems for military and civil use is projected to continue through the next decade. It is estimated that UAS spending will almost double over the next decade, from $6.6 billion to $11.4 billion on an annual basis, and the segment is expected to generate $89 billion in the next 10 years.[10]

Unmanned Aerial Systems: Military Versatility, Civilian Potential

Persistent Intelligence, Surveillance and Reconnaissance (Persistent ISR)

The Defense Department has described battlefield commanders' requirements for Persistent ISR as nearly "insatiable,"[11] and the technology platforms best suited to feed these requirements are UAS.

Persistent ISR refers to a sustained ability to gather intelligence from the battlefield or any area of interest through photos, videos and other sensors for the purposes of force protection, pattern recognition, targeting or damage assessment. When such data is fed in real time to commanders, the results can be dramatic.[12]

Commanders utilizing UAS surveillance can guide troops to safety or more advantageous tactical positions, direct fire missions, and help identify landing zones for medical evacuations. The Global Hawk, for example, can survey up to 40,000 square miles of terrain – an area roughly the size of Ohio – in a single day.[13] This capability gives battlefield commanders one of the most critical advantages over their adversaries: the ability to see a picture of the entire battlefield, including friendly and enemy movement, in real time.

In Afghanistan and Iraq, commanders have not only watched enemy fighters plant IEDs, but have also been able to target them before they finish the job. In areas like these where coalition forces have suffered thousands of casualties from IED strikes, this capability is saving lives.

Tactical Applications

Perhaps the most dramatic deployments of UAS involve kinetic strikes on military targets. For these missions, armed forces utilize UAVs capable of carrying armed payloads. Equipped for live video feeds, these UAS missions are remarkably accurate. Yet the same video capabilities that help inform command decisions are also those creating false perceptions of "drone" strikes in news reports and on YouTube clips worldwide.

UAS strikes involve decisions in a human chain of command. This chain of command views information from UAS surveillance, processes other intelligence, considers strategic impact, rules of engagement and immediate concerns such as the likelihood of civilian casualties. Due to longer "loiter" times on target, and advances in surveillance imaging provided by UAS, strikes are becoming incredibly accurate.

> "When U.S. forces took out Abu Musab al-Zarqawi, a leader of al-Qaida-in-Iraq, that operation involved about 6,000 hours of Predator time, thousands of hours of analyst time, and about six minutes of F-16 time."
>
> Lt. Gen. David Deptula
> Deputy Chief of Staff for ISR, USAF

CRITICAL COMPONENTS: SENSOR TECHNOLOGY

For surveillance missions, a high-altitude, unmanned aircraft is only as good as its sensor package. Thankfully, sensor technology is rapidly advancing to keep up with the most advanced UAS platforms. The ARGUS, under development by the Department of Defense can take in 30 square miles of live video at incredibly high resolution. The sensor uses a 1.8 gigapixel camera, using parts similar to those found in smart phones.

As policymakers, commercial enterprises and civilian government agencies weigh the potential for UAS use in domestic airspace, unmanned systems continue to prove beneficial in defense applications overseas and in limited use for border patrol and other missions in the continental United States. In military areas of operation, UAS have become valuable force multipliers, intelligence gatherers and life-savers.

A variety of UAV platforms are in production to suit military missions. They range in size from the "micro" U.S. Marine Corps Wasp – with a weight of 2.8 pounds, a service ceiling of 10,000 feet, and flight endurance of just 60 minutes – to the Air Force RQ-4 Global Hawk, which weighs 7,600 pounds, has a service ceiling of 60,000 feet and can stay in the air for 32 hours at a time. These assets provide two capabilities of paramount importance to the U.S. military: Persistent Intelligence, Surveillance and Reconnaissance; and enhanced tactical strike accuracy.

In 2012, for example, the U.S. Army Armament Research and Development Engineering Center successfully demonstrated a GPS-guided munition for use on small UAVs. The testing consisted of three separate engagements using a Tiger Shark UAV to launch an 81mm mortar. All three mortars were launched at altitudes of approximately 7,000 feet and guided to within seven meters of a GPS-identified target.[14] In addition, other factors – such as a shortened chain of command between pilots and mission decision makers – are likely leading to a reduction of civilian casualties and property damage.

Dr. Edward Barrett, Director of Research at the U.S. Naval Academy's Stockdale Center, has testified regarding a false assumption that "soldiers engaged in such 'virtual warfare' are less situationally aware, and also less restrained because of emotional detachment. However, accumulating data points in the opposite direction, sensor improvements, lack of fear-induced haste, reduced anger levels, and crystal clarity about strike damage all combine to actually enhance awareness and restraint."[15]

With UAS technologies, the service men and women responsible for making these life-or-death decisions today have an unprecedented level of information and context with which to inform their commands.

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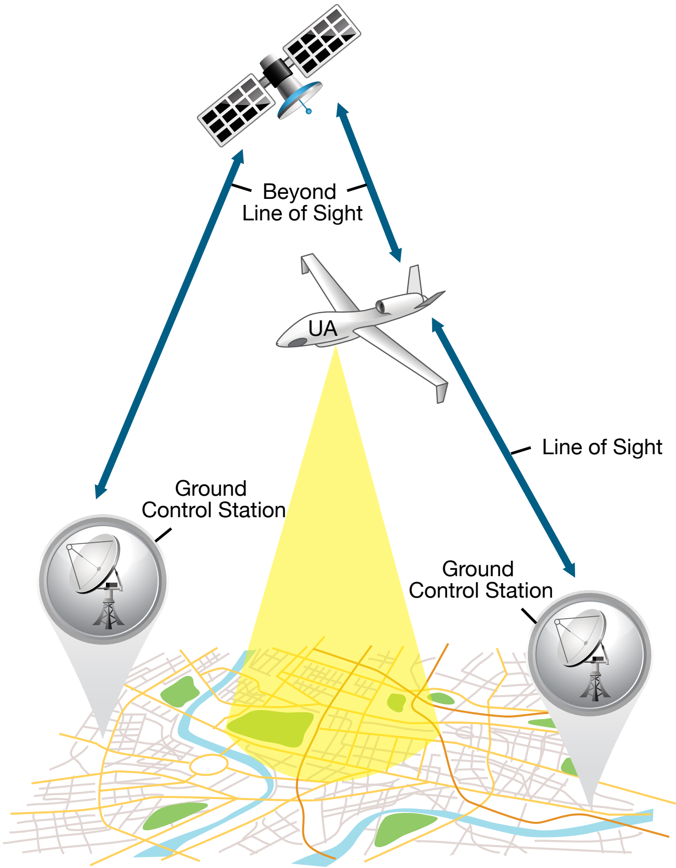

UNMANNED, NOT UNPILOTED

The use of the term "drone" to describe most UAS platforms is a misnomer. The vast majority of UAS flights are piloted by ground-based personnel. Pilots for these "remotely piloted aircraft," or RPAs – growing in number every year – are part of a three-component framework that controls the flights: the unmanned aircraft (UA), the ground control station (GCS), and the communications link between the two. For flights beyond line-of-sight control (over the horizon), UAVs use additional satellite control and ground control stations. Even when flying pre-programmed routes and missions, real-time pilot intervention is always available.

Pilots & Operators

The role of the UAS pilot is another commonly underutilized plot point in the "drone strike" narrative. It has recently become a temptation for some to resort to science fiction and theoretical work on "ethically superior" robots[16] as the basis for discussion of the moral, legal and ethical concerns surrounding lethal UAS deployments. But the fact remains that only people make decisions regarding UAS missions and tactics.

The growth in unmanned systems is, in fact, creating a demand for more pilots, and training standards and procedures are changing to keep up. In 2009, the Air Force launched new measures to expand UAS capabilities in response to the ever-growing demand for unmanned systems. In a series of firsts, freshly minted pilots were sent directly to fly UAS for their initial assignments, and UAS operators were given their own distinct career field.

The training would increase the number of UAS pilots dramatically. Brig. Gen. Lyn D. Sherlock, director of air operations for the Air Staff's directorate of operations, noted that the size of the UAS pilot community would soon be second only to that of the F-16.[17] In 2012, the U.S. Air Force actually trained more UAS pilots than traditional fighter pilots, introducing the likelihood that one day UAS pilots would outnumber F-16 pilots as well.[18]

> Candidates for Air Force UAS training are screened for many of the same skills and traits as traditional pilots, including motor skills, vision and personality traits such as decision-making capabilities under stress.

A more constructive framework for discussion of lethal UAS capabilities would acknowledge that these systems are under the real-time control of pilots and operators and that they play only a role in the military chain of command. Informing and training the personnel in this chain of command – in order to ensure the most effective combat decisions – should serve as the basis for ongoing discussion regarding UAS technology use.

This approach – with its focus on decision-making and leadership – has already been adopted by the U.S. Naval Academy's Stockdale Center for Ethical Leadership, and is part of the curriculum at a handful of civilian post-secondary institutions that have begun UAS training for domestic use.

Domestic Applications

Projections for UAS market growth are driven by the increasing number of units required for national defense, but also for the demand expected from a wide variety of uses by commercial enterprises, public institutions and non-defense government agencies.

UAS domestic applications are predicted to include search and rescue, weather forecasting, law enforcement, border patrol, firefighting, disaster response, precision farming, commercial fisheries, scientific research, aerial photography, mail delivery, communications relay, infrastructure monitoring and emergency management – just to name a few. In fact, many of these applications are currently in use.

When Americans are asked whether they support specific uses of UAS systems, their responses are positive. A survey by Monmouth University shows strong public support for civil UAS operations. Of those surveyed, 80 percent approved of UAS use in search and rescue missions, 67 percent supported their use to track down criminals at large, and 64 percent said they should be used to patrol U.S. borders.

The benefits promised from domestic UAS deployments sound utopian: more accurate weather forecasts, safer streets, bumper crops and fewer Americans engaged in dangerous jobs such as search and rescue missions, fugitive pursuits and firefighting.

Alaska Pioneers UAS Search & Rescue

Smith Services Alaska, a construction company specializing in remote locations, recently announced that it would make its aerial photography UAS available for community search and rescue missions.[19]

UAVs were recently deployed to survey California wildfires. Thermal images provided crucial mapping to keep emergency responders out of harm's way.

So what's standing in the way?

U.S. T-Hawk systems were deployed to examine damaged reactors in Fukushima, Japan at the request of the Tokyo Electric Power Company following the 2011 Tōhoku earthquake and tsunami.

Obstacles to UAS Sector Growth

Spectrum Allocation

UAS communications, both for command and control and the transmission of data, require a portion of the electromagnetic spectrum, which is already in very short supply. Without sufficient spectrum, UAS signals may interfere with other forms of communication.[20]

While spectrum allocations for radio line-of-sight communications for UAS operations have been secured, work toward securing ample allocations for those requiring radio beyond-line-of-sight communications via satellite must continue.

A Way Forward

The United Nations International Telecommunications Union (ITU) is working with the International Civil Aviation Organization (ICAO) to provide a safe, global communications infrastructure for UAS operations. One option presented to ITU by the U.S. government – with industry support – is the use of fixed satellite service, which is in abundance and can safely support the projected growth of the UAS market for years to come.

PRIVACY CONCERNS DEMAND A MEANINGFUL FRAMEWORK FOR DISCUSSION

Public concerns, such as privacy, require a non-technical framework for meaningful discussion including:

LEGAL: How might due process laws governing manned surveillance flights apply to UAS?

DATA SECURITY: What government regulations regarding data and IT system security could be adapted for protecting data collected by unmanned systems?

ONLINE PRIVACY: How have individuals and communities adapted to or driven the evolution in what is considered private? UAS capabilities should be considered in the context of the new normal: the ubiquity of handheld video devices and availability of video content, the prevalence of security and traffic monitoring cameras throughout our communities, the voluntary surrender of personal information through social media, and the implicit sharing of personal data (for use by marketers/advertisers) through online activity.

The impediments to more widespread UAS use include policies that have not yet adapted to unmanned flight in national airspace, pre-emptive restrictions on UAS flights in the national airspace, and trade controls that could restrict U.S. competitiveness in the global UAS marketplace.

UAS Integration into the National Airspace System

Accommodating unmanned aircraft in the U.S. National Airspace System (NAS) presents a significant challenge to regulators. The current air traffic control system could have difficulties accommodating estimated increases in the number of manned flights that will vie for a place in American skies in the next 20 years. This challenge will be addressed in part by a new air traffic control system – NextGen – that will enable the Federal Aviation Administration (FAA), to safely and efficiently support current and future airspace demands. The NextGen system – based largely on satellite and digital communications – includes capabilities that would allow UAS to operate more safely inside the United States.

As part of the transition to NextGen, the FAA and its partners are developing solutions that would integrate data from UAS ground control stations, share real-time flight data with Air Traffic Control systems, and establish two-way communications between UAS pilots and air traffic controllers. This work is ongoing.

In the short term, the FAA Modernization and Reform Act of 2012 directs the agency to develop a certification process for domestic unmanned aircraft systems, and requires the FAA to select six test sites as part of a comprehensive plan to integrate commercial and civil unmanned systems into the NAS by September 2015.

It is vital that Congress provide FAA with the resources necessary to achieve this important milestone. UAS integration by 2015 requires a funded, timely, focused standards development and certification process. Some unmanned systems must be type certified to facilitate NAS integration, which may take several years. A lack of long-term funding commitments and sequestration pose a threat to UAS integration.

> One of the greatest challenges to UAS airspace integration is a growing number of states and communities that have passed laws banning or restricting the use of UAS.

One of the greatest threats to UAS airspace integration is a growing number of states and communities that have passed laws – the majority of which appear to be focused on personal privacy concerns – banning or restricting the use of UAS. A national framework must be identified to address the concerns of these communities while avoiding the creation of a national patchwork of conflicting rules that may ultimately limit UAS use for public service missions. An appropriate first step would be the creation of national privacy objectives and guidelines.

PROGRESS TO DATE

In response to UAS sector growth, the FAA has:

- **Expedited procedures to grant one-time UAS flight authorizations for emergency missions such as disaster relief and humanitarian efforts.**
- **Collaborated with the Department of Justice's National Institute of Justice to establish and implement a memorandum of understanding whereby law enforcement organizations, having shown operational proficiency, will receive authorization to operate unmanned aircraft weighing up to 25 pounds within their respective jurisdictions.**
- **Lengthened the Certificate of Authorization for unmanned systems from the current 12-month period to 24 months.**
- **Developed a draft rule for the operation of small UAS (under 55 lbs.). However, work remains to develop additional rules covering all UAS categories.**

The Outdated Missile Technology Control Regime

As U. S. defense budgets decline, maintaining a strong U. S. aerospace industry will increasingly depend on an effective export strategy for technologies where the United States is a global leader. There is no better example than UAS. According to the Defense Security Cooperation Agency, approximately 556 models of unmanned systems are produced worldwide by 195 companies.[21] While the United States enjoys technological and global market dominance for the time being, this position is threatened by the application of the Missile Technology Control Regime (MTCR) to UAS exports, and other nations are taking advantage of those issues.

A Competitive Global Marketplace

556
Number of unmanned systems produced worldwide in 2009

195
Number of companies worldwide producing unmanned systems

The MTCR is an informal and voluntary set of commitments agreed to by an association of countries that share non-proliferation goals for systems capable of delivering weapons of mass destruction.

The 25-year-old regime has been an effective tool in limiting the proliferation of weapons of mass destruction delivery systems like missiles, but it has not evolved to account for the current and potential use of modern unmanned systems, particularly those models primarily designed for civil use.

The MTCR places missiles into two categories. "Category I" systems are capable of carrying a 500 kilogram payload as far as 300 kilometers, and "Category II" systems are all others with less than Category I capability. A system is also considered Category I if it can be modified to meet the Category I threshold. Since UAS can have the same range and payload capabilities as missiles, they are automatically subject to the MTCR.

As a structure originally designed to protect against the proliferation of ballistic missile, space launch vehicle, rocket and cruise missile technology, the MTCR framework needs to be reformed to distinguish properly between these systems and UAS. The last attempt in 2007 was unsuccessful, as the 34 MTCR nations failed to reach agreement on specific new language.

Until such revisions are incorporated into the MTCR, the United States must ensure its application of the provisions of the MTCR do not needlessly impinge upon the national security, foreign policy and eventual economic and societal benefits of American UAS exports, which include the creation of up to 100,000 jobs and a contribution of $82 billion toward U.S. Gross Domestic Product by 2025.[22]

A TWO-PRONGED APPROACH TO REFORM

Changes to the MTCR will help ensure that American unmanned systems remain available to markets around the world. These changes must include:

- **Continued efforts to update the MTCR with respect to UAS technology**
- **Consistent and appropriate flexibility applying the current MTCR transfer guidelines**

Misconceptions

It's tough being a "drone," especially when the public doesn't even recognize you for what you are: an unmanned aerial vehicle under human control through a sophisticated ground-based control system.

Until public discussion moves beyond misnomers and false assumptions about unmanned systems, it will be difficult to advance substantive policy changes that enable growth of this highly beneficial technology. Starting the conversation begins with understanding myths versus facts:

MYTH	REALITY
UAS are dangerous to manned aircraft and people on the ground	Industry is advancing technology that enables a UAS operator to have a similar situational awareness to a pilot physically in the cockpit. In fact, there are cases in which the UAS pilot has better situational awareness. This capability, called "sense and avoid," will demonstrate that UAS can be operated safely in the same airspace as manned aircraft.
They are best suited to military use.	UAS are being used for law enforcement, forest fire monitoring, wildlife monitoring, and a variety of other civilian tasks. For example, the National Oceanic and Atmospheric Administration has used the Aerosonde UAS for the past six years as a hurricane hunter, and trained geophysicists are using UAS systems to predict the location of mineral deposits. Unmanned systems have also been utilized to help save lives in cases of natural disaster. The Association for Unmanned Vehicle Systems International also predicts high demand for agricultural UAS that will be able to spray crops with herbicide and pesticide and offers access to cheap, timely data on crop health.[23]
Unmanned systems do not represent a significant aeronautical market.	Of the 1,581 UAS types built in 2012, 377 were built in the United States. Among those, the number of UAS types procured for civil use rose from 55 in the year 2005 to 217 in 2012.
Unmanned systems represent a privacy threat.	Privacy concerns are similar to those related to surveillance by manned aircraft and any handheld or static device capable of capturing imagery. But unlike smart phone video content, UAS surveillance missions and the information they generate will likely be highly regulated – by multiple government agencies and under laws protecting personal privacy and due process.

Conclusions: Ensuring UAS sector growth, innovation and U.S. competitiveness

UAS and other unmanned systems are not only here to stay, they are the next big thing in aviation. Today, very few UAS flight hours are logged in U.S. civil airspace, but that is going to change – and soon.

With dramatic domestic growth projected for the use of unmanned systems, the impact will be significant in the aerospace sector, and likely for the U.S. economy as well. While the implications are difficult to fully predict, there is tremendous potential in the UAS market for job creation and economic growth, both directly in the UAS manufacturing sector and indirectly through UAS support and the economic benefits from their use.

The present U.S. air traffic control system is not well equipped to handle UAS traffic, underscoring the importance of NextGen, which will allow UAS to be operated safely and efficiently inside domestic airspace. FAA aircraft certification rules must also keep up with the demand for UAS design, production and operation in the United States.

Other regulations that must be updated include the multilateral MTCR – which was written to control ballistic missile technology transfer before modern unmanned systems were even in widespread use. Ample spectrum allocations for UAS command and control – as well as payload – communications must also be a priority among U.S. regulators.

The United States currently leads the world in unmanned systems technologies, but that doesn't mean it holds a monopoly. Policymakers and regulators must do everything possible to ensure U.S. competitiveness in this new era of aerospace innovation – starting with these steps:

- Embrace the Future: Embrace new UAS technologies that will yield tremendous safety, security and societal benefits at the national and local levels across a variety of sectors and industries.

- Abandon Misconception: Avoid science fiction-driven assumptions about unmanned systems in favor of a discussion that includes benefits, based on current and evolving capabilities, and manageable operational risks.

- Consider the Potential: Develop and revise rules and regulations to spur growth in a vital sector of the U.S. economy and inspire the next generation of aerospace innovators.

Many scientists parallel unmanned systems today to where we were with 'horseless carriages' back in 1909-1910, at the start of something so big we can only wrap our minds around what it is not. That is, automobiles and the resulting mechanization didn't just become change industry and warfare, it also […] led to the requirement of new laws, 'traffic laws.'

The point here is that every so often in history, the emergence of a new technology changes our world.

– Peter Singer, Ph.D.
Senior Fellow and Director
21st Century Defense Initiative
The Brookings Institution [1]

[1] Statement of Peter Singer, Ph.D., Senior Fellow and Director, 21st Century Defense Initiative, The Brookings Institution, before the U.S. House of Representatives, Committee on Oversight and Government Reform, Subcommittee on National Security and Foreign Affairs, March 23, 2010.

[2] Among military users such as the U.S. Air Force, UAVs are also referred to as Remotely Piloted Aircraft (RPA) or Remotely Piloted Vehicles (RPVs).

[3] With some exceptions, including a draft United Nations report on the use of "killer robots" that states that autonomous systems of any kind "should not have the power of life and death over human beings." Source: Associated Press, "UN report wants moratorium on killer robots" May 2, 2013.

[4] Army News Service, January 16, 2005, http://usmilitary.about.com/od/armyweapons/a/eodrobot.htm.

[5] New York Times, "Navy Rushes Robotic Tools to Clear Mines to Persian Gulf," November 14, 2012. http://www.nytimes.com/2012/11/15/world/middleeast/navy-sends-more-robotic-mine-clearing-systems-to-persian-gulf.html?_r=0.

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[9] AIA Briefing: "UAS Capabilities," September 9, 2011, by the Defense Security Cooperation Agency, Weapons Division/Navy International Programs, U.S. Department of Defense.

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[11] U.S. Department of Defense. Persistent Intelligence, Surveillance, and Reconnaissance: Planning and Direction/Joint Integrating Concept. March 29, 2007.

[12] AIA Briefing. Ibid.

[13] U.S. Air Force: http://www.af.mil/information/factsheets/factsheet.asp?id=13225.

[14] SUAS News: "General Dynamics, US Army Team On Tactical UAS," November 1, 2012. http://www.suasnews.com/2012/11/19483/general-dynamics-us-army-team-on-tactical-uas/.

[15] Statement of Dr. Edward Barrett, Director of Research, Stockdale Center, United States Naval Academy: "Rise of the Drones: Unmanned Systems and the Future of War", hearing of the House Committee on Oversight and Government Reform Subcommittee on National Security and Foreign Affairs, March 23, 2010.

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