NATIONAL MUSEUM OF THE UNITED STATES AIR FORCE

Wings & Things Guest Lecture Series

Unmanned Aircraft Systems

Col. Christopher Coombs, commander of the 703rd Aeronautical Systems Group at Wright-Patterson Air Force Base, discussed the contributions of unmanned aircraft systems to the nation's air arsenal.

Good evening, and thank you very much, Dr. Underwood, for that introduction. I'd like to extend a special thanks to Gen. Hudson for being here this evening. Gen. Hudson is the new deputy director at the National Museum of the Air Force and the former commander of the Aeronautical Systems Center and Air Force Program Executive Officer for Aircraft. Welcome, Gen. Hudson, and thanks for taking the time out of your busy schedule to be here.

It's a pleasure to be here at the National Museum of the U.S. Air Force to make this presentation. I'll spend about an hour giving you a presentation, and I'll ask that you'll hold your questions till the end, and I'll spend about 30 minutes addressing those.

And it's an honor to participate in the Air Force Museum's very prestigious guest lecture series. I would also like thank you each for taking time to attend and hear tonight's presentation on Unmanned Aircraft Systems. This happens to be a favorite of mine.

Here's the focus of my presentation this evening. The Air Force's Unmanned Aircraft Systems – or UASs – represent a capability that is changing many aspects of how the Air Force thinks about itself, and how we apply mass and economy of force in, through and from the air, both in war and in support of national crises.

I appreciate this opportunity to share my perspective on the Air Force's rapidly-evolving Unmanned Aircraft Systems – often referred to as Remotely Piloted Aircraft – capabilities. As Dr. Underwood started in the beginning, there's a lot of debate over whether it's called Remotely Piloted Aircraft, or you've also heard Unmanned Aircraft Systems. Recently, the decision was made that RPAs will refer to the aircraft in and of itself. When you talk of an entire system, which would be ground control stations, the personnel that operate it as well as the aircraft, those are known as UASs or Unmanned Aircraft Systems, so I'll refer to those that way throughout my presentation.

The Air Force has been operating remotely piloted aircraft for over 60 years now. This gives us a unique perspective on Unmanned Aircraft Systems capabilities and future opportunities to advance and leverage them for the Air Force's and Joint Force's maximum benefit. So I'll walk though what we've learned to date and how that's helped shape the Air Force vision for the way ahead. I'll take you through the highlights of our recently published May 18, 2009, Air Force Unmanned Aircraft Systems Flight Plan for 2009 through 2047. And I will conclude with a topic that I'll refer to as domains and environments where I'll leave us all with a cautionary note of the

threat environments we face in the future.

First, a little background info on the organization that I command here at the Aeronautical Systems Center. I'm the commander of the Predator/Reaper Medium Altitude Unmanned Aircraft Systems Program Office, which is responsible for the procurement of Remotely Piloted Aircraft here at the Aeronautical Systems Center.

Here's a little more on where I fit into the Air Force management structure. I report to Brig. Gen. John Thompson, who serves as commander of the 303rd Aeronautical Systems Wing and is the Air Force Program Executive Officer for Intelligence, Surveillance and Reconnaissance, otherwise known as ISR.

On March 1, 2010, Col. Hauck will move from the ASC vice commander position over to Gen. Thompson's position, and Gen. Thompson will move on to serve as the Air Force Program Executive Officer for Strategic Systems at the Air Force Nuclear Weapons Center, a Headquarters Air Force Materiel Command position at Kirtland Air Force Base, New Mexico.

Mr. Van Buren, up here in the far left, is the acting Air Force Service Acquisition Executive at the Pentagon and is the next in my Air Force acquisition execution decision chain. I command the 703rd Aeronautical Systems Group, as was previously announced, here at ASC, whose mission is to arm the warfighter with timely Unmanned Aircraft Systems solutions through a high-performance team, executing acquisition excellence in all we do.

My team and I are fortunate to be located here at ASC along so many professionals and other Centers of Excellence such as the Air Force Research Lab, who assists the 303rd Wing in serving as the Air Force's Acquisition Center of Excellence for Aircraft Systems that provide capabilities in support of special forces, intelligence, surveillance and reconnaissance both today and in the future.

This chart depicts the structure of the 303rd Aeronautical Systems Wing. Gen. Thompson's team has the responsibility for assuring program executability; developing, acquiring, fielding and modernizing capabilities; providing life-cycle management support for the 303rd Wing's capabilities that arm U.S. warfighters and our coalition partners.

The 303rd Wing is responsible for a wide array of Intelligence, Surveillance and Reconnaissance programs and capabilities that include our unmanned programs and manned platforms. This wide array of programs includes 69 programs, projects and foreign military sales activities supported by approximately 1,200 personnel and responsible for almost $15.5 billion in program execution resources. The red arrows depicted on this chart highlight those 303rd organizations involved in the acquisition of Unmanned Aircraft Systems. They include the 659th Aeronautical Systems Squadron, which manages the Small Unmanned Aircraft Systems as part of their technology advancement portfolio; the 303rd Aeronautical Systems Group, which manages the Global Hawk; and the 670th Aeronautical Systems Squadron, which manages the Battlefield Air Targeting Micro Air Vehicle as part of Battlefield Airmen program.

And finally my team, the 703rd Aeronautical Systems Group, which is responsible for the

acquisition of Medium Altitude Unmanned Aircraft Systems to include the Predator and Reaper Remotely Piloted Aircraft. My team is composed of dedicated professionals who bring a broad wealth of knowledge, skills and experiences in their respected areas of expertise. I'll talk more on these unmanned capabilities later in my briefing.

As we meet here in the National Museum of the U.S. Air Force, where their motto is "The Keeper of the Stories," let me briefly review some of the history of unmanned systems.

Here, you can see that Unmanned Aircraft Systems history goes all the way back to the Bavarian Pigeon Corps, who back in 1903 acquired the 1st Winged Aerial Reconnaissance photos with a relatively high-tech system for that day.

Unmanned Aircraft Systems capabilities can be traced quite far back in time. In the late 1700s, unmanned aerostats were sent aloft in preparation for their manned flights. During the Civil War, the Union put incendiary devices on unmanned observation balloons and released them in hopes of starting fires in Confederate territory. Japan released high-altitude balloons in the jet stream in 1944 with incendiary bombs attached – their objective: to start forest fires in the United States.

The first major American UAV began appearing by the early 1900s. Charles Kettering's aerial torpedo, also known as the "Kettering Bug," was an effort backed by the U.S. Army. The Bug, which can be seen here in the Air Force Museum, where Orville Wright was a consultant on the project, and his contribution helped evolve the Bug into a gas-fueled, propeller-driven biplane which flew on a preset course for approximately 50 miles late in 1918. It eventually became capable of striking ground targets up to 75 miles from its launch point. Another forerunner of modern unmanned systems was the American Navy Curtiss/Sperry "flying bomb." This primitive cruise missile first flew on March 6, 1918. The guidance system for both aircraft – composed of a gyroscope, barometer and altimeter – were designed by Elmer Sperry and became the Sperry Corp.

By the 1940s, in time for World War II, the German "Buzz Bomb" had emerged. Over time, unmanned remotely-controlled aircraft also began emerging, which led to advancements in air vehicles and their propulsion and guidance systems.

The appearance of UASs in the mid-1990s brought unmanned aerial vehicle technology to the forefront as an essential capability to accomplish ISR missions and provide actionable intelligence to the tactical commander. Since then, the roles, missions and numbers of UASs have continued to expand at unprecedented rates. According to the Secretary of the Air Force and Chief of Staff of the Air Force, only relatively recently have "Unmanned Aircraft Systems and the effects they provide emerged as one of the most in demand capabilities the U.S. Air Force provides to the Joint Force."

Today, the Air Force is capitalizing on the potential of Unmanned Aircraft Systems across the spectrum, from very small systems confined to small locales, to those able to reach larger areas with true theater and global capability.

In terms of our weight of effort, the vast majority of Air Force systems are the larger, theater-

capable systems, such as MQ-1 Predator, MQ-9 Reaper and RQ-4 Global Hawk, shown as Group 4 and 5 Unmanned Aircraft Systems on the right size of this slide. The Air Force operates in excess of 200 of these types of systems today.

The red boxes highlighted on this chart depict the capabilities that possess what we refer to as Programs of Record. The Programs of Record term refers to programs that have been established and built on user requirements, acquisition strategies for addressing them and the necessary program execution resources.

This chart highlights the five groups within which the Air Force Unmanned Aircraft Systems Family of Systems fall. Groups are defined by size, weight, operating altitude and speed. One can also get a sense for the variety of roles and missions that are – or will be – performed by these groups of Unmanned Aircraft Systems.

The Air Force even has a variety of Small Unmanned Aircraft Systems that range in size from insects to 1,320-pound systems where technology advancements are underway. I'll cover more on some of these programs and their capabilities later in my briefing.

Now I'd like to talk to you about the topic of Information Age Warfare that the Air Force finds itself faced with. We're at a critical juncture in history – at the center of an "Information of War Revolution" – one where the speed of information, advances in technology and designs of organizations have come together to change the way we operate in, through and from the air. This change has dramatically shortened decision and reaction time and reduced the number of systems it takes to execute effective airpower missions. Where it used to take literally months and thousands of Airmen and aircraft with separate functions to attack a single target, today we can find, fix and finish a target from a single aircraft within minutes. This evolution of technology, information and culture underlies the Intelligence, Surveillance, Reconnaissance transformation we've accomplished in the Air Force and has necessitated a move from traditional segregation of operations and intelligence to the integration of operations and intelligence.

Unmanned Aircraft Systems provide some unique attributes, as many of you all are already aware. Persistence is perhaps the most significant. They can loiter over a specific area to observe, wait for a target to emerge and engage it, or translate that endurance into range. Penetration and avoidance – in permissive airspace, these aircraft are rather difficult to detect, deny or defeat. They can operate in high risk environments without the fear of loss of life. And using a Remotely Split Operations concept, which I'll talk to later in my briefing, Unmanned Aircraft Systems enable the ability to project power without projecting vulnerability. Finally, UASs give us the opportunity to bring both sensor and shooter together, integrating the find, fix and finish kill chain on a single platform.

In a *Popular Science*, Jan. 4, 2010, article entitled "University of North Dakota first to offer a four-year degree in UAV piloting," the following perspective on the importance of unmanned aerial vehicles was provided.

"Most UAVs deployed in the military are engaged in reconnaissance and intelligence gathering,

punctuated by the occasional strike, but the brass has expressed desire for faster, more networked fighting forces on the ground, and that means more UAVs acting as eyes in the sky. While the Cold War-era intel gathering employed satellites and high-flying spy planes to follow broader actions like following troop column movements and monitoring large missile installations, the emerging threats of the 21st century – multiple small global targets hiding in very hard to reach places – require a more fleeted-foot, unit-level means of intelligence gathering and troop support."

Because of these Unmanned Aircraft Systems' attributes and the permissive airspace environment we currently enjoy, UASs have become high-demand assets. We've seen in excess of a 650 percent increase in Predator and Reaper missions alone over the last six years, and there's no end in sight for this demand.

In fact, the Air Force has been in a "surge" mode with our Unmanned Aircraft Systems for over two years. Coming out of 2006, the official DoD Program of Record for the MQ-1 Predator called for 21 Combat Air Patrols, or CAPs, by 2010. In 2007 the "demand signal" from the Combatant Commanders increased far in excess of that Program of Record goal. The Air Force responded by rapidly adding capability well beyond that 21 CAP goal, and then more than doubled the MQ-1/MQ-9 CAP to 50. And the most recent Predator and Reaper requirement is driving that 50 CAP goal to 65 CAPs or even more in the future.

To take my last chart one step further to illustrate the type of surge capability we're routinely providing … in December 2008, we reached 31 MQ-1 Combat Air Patrols – 10 more than the Predator Program of Record plan and more than a year ahead of the 2010 21-CAP target date. Today we're flying 38 combined MQ-1 Predator and MQ-9 Reaper CAPs. That's over a 300 percent growth in just two years. And, again, we're well on our way to meeting our requirement to provide 50 Predator and Reaper Combat Air Patrols by the end of 2011. And we're now postured to meet our requirement to increase the 50 CAPs to 65 shortly after that.

With this background on the Info Age Warfare challenge, I'd like to now address the Air Force's UAS vision. Air Force experience has shaped the Air Force's vision and what we believe about where we need to go with Unmanned Aircraft Systems. This chart summarizes that. We want to get the most out of UAS to increase joint warfighting capability while promoting service interdependency and the wisest use of tax dollars. To do that, we need a process that addresses each of the challenges listed on this chart. We need a joint, interdependent approach that embraces a cross-service, multi-domain Concept of Operations. We need to rapidly address the challenges of safe and effective airspace control. We need to build an air defense architecture that can rapidly deal with adversary Unmanned Aircraft Systems capabilities without fratricide. The audience should keep in mind that for the past 18 years, we've dominated the airspace. What's in the air has been ours. This condition won't last forever. We need to build an air defense architecture that can deal with adversary UASs without fratricide. At the same time, the wisest use of taxpayer dollars calls for introducing standardization, efficiency and effectiveness into the acquisition process before aircraft are produced, not after. And this is what we're doing and we're all about.

Remotely Piloted Aircraft technology is growing at an amazing rate. It's redefining our concepts

of mass and economy of force in aerial warfare. We've gone from having thousands of aircraft and tens of thousands of Airmen and weapons required to destroy a single target yesterday, to today where we can now have a single crew engage multiple targets. And we've already demonstrated Multiple Aircraft Control by one crew, and we believe this evolution will continue to encompass a swarm-like autonomous, remotely-directed man-out-of-the-loop capability in the future.

From the vantage point of Air Force technology and experience, we've developed some tenets of Unmanned Aircraft Systems evolution that chart our way ahead. First, we find UASs to be compelling where a human in the aircraft would limit the mission. Many have already come to know these Unmanned Aircraft Systems as guardian angels that stand continuous watch over our troops and protect them from harm. At the same time, we've not seen the end of manned aircraft. Accordingly, we'll focus on seamless manned and unmanned systems integration, where Unmanned Aircraft Systems aren't just a viable alternative to manned systems, but a seamless part of our thinking, employment and acquisition. In the future, autonomy will be vital in every aspect of Unmanned Aircraft Systems operations and will alleviate many of the vulnerabilities of current systems. We'll pursue an integrated systems approach where sensor, weapons and platform are designed seamlessly from the start. Modularity will be a critical design element to enhance platform flexibility. Adapting command and control with autonomy will be a challenge, but it will also be a must. And most important to recognize, there are no single solution sets. Technology will advance and will dramatically impact the potential of these aircraft.

With the Air Force's Unmanned Aircraft Systems Vision as a foundational framework, I'll now move on to the United States Air Force Unmanned Aircraft Systems Flight Plan, the aim of which is to turn this vision into reality. The flight plan was co-signed by the Secretary of the Air Force Michael B. Donley and the Air Force Chief of Staff Norton A. Schwartz on May 18, 2009. Its vision for an unmanned future is built on the Air Force tenets listed on this chart and detailed in the flight plan. The flight plan outlines not just platform potential, but an entire spectrum of changes that involve balancing technologies, risks and mission objectives.

The flight plan was designed with the Air Force's core functions in mind. These Air Force core functions were developed as part of a year-long process in conjunction with the Defense Department's Quadrennial Defense Review. Core functions identify what the individual services bring to a joint operation, and we anticipate a future where Unmanned Aircraft Systems will contribute to each one of the core functions listed on this chart.

While this is a busy chart, it depicts the areas where the Air Force envisions applying Unmanned Aircraft Systems capabilities. The main thrust of the Air Force's UAS Flight Plan balances present and future technology to identify where we can apply UAS potential in the core functions listed.

While there's numerous areas where the UAS capabilities are already being or beginning to be leveraged, I'll highlight several examples where our 303rd Aeronautical Systems Wing's UAS capabilities are already being applied. While we see a near-term shortfall in close-controlled strike (global precision attack row), we're already adding and rapidly expanding lethal capabilities to UASs, and Predators and Reapers are players already. There's much room for

expansion in force connectivity and info integration in the C2 row of this chart, as well as in the electronic warfare and suppression of enemy air defenses – in the air superiority row – arenas. Predator, Reaper and Global Hawk systems' with their associated ground control stations and communications capabilities are already being leveraged and improved, as are Predator/Reaper strike capabilities. In the nuclear deterrence/ballistic missile defense arena, under the nuclear deterrence row, Reaper capabilities are being leveraged to potentially support the missile defense industry's missile defense architecture. In the combat search and rescue function's – third row from the bottom – disaster response and humanitarian assistance operation arenas, Predator, Reaper and Global Hawk continue to serve – as they have for some time – in contingency and peace operations.

The Chief of Staff of the Air Force, in his October 8, 2009, speech to the Air Force Historical Foundation, stated the following: "Providing on-scene support 24 hours a day, seven days a week, and 365 days a year, in both Iraq and Afghanistan, our UAVs perform that critical ISR role and more – for example, precision strike, close air support, and combat search and rescue. This exponential demand for constant surveillance and support shows no sign of abating."

The bottom line here is the Predator, Reaper and Global Hawk are examples of UASs already being leveraged to support growth in Air Force core functions and capabilities.

Now that I've covered information on the Air Force's UAS vision and flight plan, I'd like to now move on to providing you with a sense that the contribution that today's UASs are making. This section will be divided into three classes of UASs, starting with Small Unmanned Aircraft Systems.

Small UASs are designed in large part to provide improved situational awareness to Security Forces and Special Operation Forces. In general, they support tactical use by small teams, and they support base defense and convoy protection. Small Unmanned Aircraft Systems' sizes range from insect size – or what we refer to as nano or micro size – up to 1,320 pounds. Their designs may incorporate electric and gasoline engines. They may also incorporate electro-optical (or EO) and infrared sensors, side-looking airborne radar, and communication relay payloads. They may be hand-, rail- or air-launched, and they possess endurances from one to 24 hours.

Now I'd like to move on to an example of one of our Small Unmanned Aircraft Systems that is already being procured and provided to our Battlefield Airmen for operational use … the Battlefield Air Targeting Micro Air Vehicle, or BATMAV system.

The Battlefield Air Targeting Micro Air Vehicle (or BATMAV), or also known Wasp Micro-UAV, was developed by AeroVironment Inc. under a DARPA (or Defense Advanced Research Projects Agency) contract in 2000. The 303rd Aeronautical Systems Wing's 670th Aeronautical Systems Squadron partnered with the Air Force Research Lab to support and continue the development and to provide this capability to the Battlefield Airmen. The WASP III won a competitive fly-off during source selection aimed at acquiring the best capabilities for our warfighting customers. The key to this system's capabilities is that it's small and light enough to be carried by an individual Airman in the most rugged terrain, and hand-launched enabling him to have real-time streaming video of a target without exposing himself to danger. I'll show you a

video of this capability later in my briefing.

The initial operation capability was achieved in May 2003, and it was then immediately placed into combat. Feedback from the users is helping the BATMAV acquisition team to systems engineer and improve capabilities for the warfighter. Here are several examples of the type of feedback that has been received. Bringing beyond-line-of-sight capability to the warfighter has proven extremely effective in saving U.S. lives and bringing heavy firepower to bear on the enemy in real-time. This micro unmanned aerial vehicle also provides precise targeting data to the Battlefield Airman, which can be seamlessly exploited by traditional platforms. We fully expect to see the use and feedback trend accelerate as Airmen become more familiar with its capability, and we expand its capability. And as AFSOC receives an additional 33 systems in this fiscal year, we'll utilize their feedback to further improve on this capability. The bottom line is that the Air Force Combat Controllers are impressed with BATMAV's capabilities. As you can see in the status box on this chart, during 2010 we'll be expending significant effort to enhance and test improved BATMAV capability for our warfighters.

So I've discussed the Small Unmanned Aircraft Systems. Let me spend a little time discussing our larger UASs such as the Predator and Reaper systems.

This chart is designed to show how the Air Force Predator and Reaper are used. When operating these Remotely Piloted Aircraft, the Air Force uses a concept of operations referred to as remote split ops. As was mentioned earlier, this CONOP is employed enabling continental U.S.-based crews to very effectively command and control Predators and Reapers from halfway around the world. These aircrews control highly responsive Predators and Reapers thousands of miles from the war zone using this remote split operations CONOP, which minimizes to forward deployed system footprint, minimizes the in-theater troops and equipment costs, and maximizes protection to U.S. and Allied warfighters. The point I want to again emphasize … Unmanned Aircraft Systems enable our warfighters to project power without projecting vulnerability.

This chart provides a summary of the recent operational successes supported by the Predator and Reaper capabilities. Within the past year, each of these systems has successfully surpassed significant total flight hour milestones. Predator surpassed it 500,000 total flight hours mark in February 2009. As of February 28, 2010, 697,000 hours have been amassed, with over 88 percent in direct support of combat operations. Reaper surpassed its 50,000 total flight hours mark in September of 2009. And within five months, it has amassed 72,000 total flight hours, with approximately 80 percent of those in direct support of combat operations. With all these flight hours, you can see why the 432nd Wing Commander at Creech Air Force Base, whose team operates Predators and Reapers, stated that these systems are "the most requested Air Force battlefield systems in Operations Iraqi Freedom and Enduring Freedom." Imagine where we'll be when we achieve 50 Combat Air Patrols requirement by FY11 and the 65 CAP Predator-Reaper Air Force requirement in the near future.

This chart depicts the Air Force concept of operations of remote split ops – similar to the remote split operations chart I covered with Predator/Reaper a moment ago. This one depicts the current Global Hawk developmental test configuration. Rather than get into all the details on this chart, I'd like to leave you with several key points on it. One is that under the remote split operations

concept of operations for Global Hawk, it enables a connectivity between the forward-based launch and recovery element and the CONUS-based mission control element. Timely intelligence, surveillance and reconnaissance information is made available to not only the CONUS-based mission control element crew, but to a number of other geographically-dispersed customers. And, as with the Predator and Reaper, the Global Hawk crew is able to command and control a very robust Global Hawk capability thousands of miles away from forward locations. This, again, minimizes the forward deployed system footprint, minimizes in-theater troops and equipment costs, and maximizes required support to U.S. and Allied warfighters. Again, Global Hawk is another example of how the UASs enable the ability to project power without projecting vulnerability.

This chart provides a summary of the recent operational success contributed to by the Global Hawk Unmanned Aircraft Systems. Let me summarize the key take-away from this chart. As of January 31, 2010, 38,000 plus total flight hours have been accrued, with 30,000 of those (or greater than 79 percent) in direct support of combat operations.

In the next several charts, we'll focus on UAS' game-changing capabilities. Yesterday's technology enabled the Air Force to slip "the surly bounds of earth." Today's has progressed to the point where pilots on the ground can now remotely operate highly capable, highly maneuverable and highly versatile unmanned vehicles. Crews at Creech Air Force Base, for example, already plan, prepare and execute Predator and Reaper missions and establish critical command and control intel, surveillance and recon links in support of our forces half a world away. As we've seen, this remote split operations concept of ops also applies to Global Hawk.

The Unmanned Aircraft Systems they operate are equipped with television and infrared full-motion video cameras to track stationary and mobile targets across a wide area. Some of these aircraft are also armed with precision weapons so that, when necessary, our crews can provide fire support and destroy those targets.

From the on-board sensors, critical raw data is collected and is sent to intelligence counterparts around the world, through our distributed ground systems teams who process this data, fuse it with data from other sources, evaluate and turn this value-added info into actionable intelligence. They then disseminate it rapidly to the commanders in the field. It's critical work, and our shooters on the ground rely on the surveillance capabilities that these Unmanned Aircraft Systems provide to tell them what is around the corner, behind the wall or on the roof. In the words of the Chief of Staff of the Air Force, "It is truly a game-changing capability."

The next several charts summarize some of the other game-changing capabilities that Unmanned Aircraft Systems are already contribution, or are expected to contribute.

This video clip graphically illustrates the remote split ops capability that I've already addressed in Predator/Reaper and Global Hawk charts. You'll be able to see how a continental U.S.-based crew can prosecute a target with pin-point accuracy using the Reaper system halfway around the world. The ability to prosecute targets with such high efficiency and precision that far away, without projecting vulnerabilities, is truly another game-changing capability that Unmanned Aircraft Systems bring to the joint fight.

[sound effects from video]

I've already spoken to the fact that Unmanned Aircraft Systems provide an efficiency and flexibility via their modularity and automation capabilities that may be leveraged to offer our warfighters a wider range of combat capability effects. In leveraging their modularity and automation, the intent will be to enable our warfighters with a variety of Unmanned Aircraft Systems capabilities such as intelligence, surveillance and reconnaissance; ISR wide area surveillance; armed reconnaissance; precision attack and other effects, as well as to enable the amount of capability required to prosecute a variety of targets of interest most efficiently and cost-effectively. The modularity and automation that Unmanned Aircraft Systems bring to the fight are already enabling this type of capability, and the Air Force will continue to improve on such capabilities in the future.

[music from video]

And to bring this presentation back around to my earlier comments about the Air Force's efforts to advance Small Unmanned Aircraft Systems capabilities, I'd like to provide you with a bit more on that by showing you this video on Micro Air Vehicles. These will improve warfighting capabilities while also providing combatant commanders with increased warfighting capability options. They will also possess game-changing capabilities.

[narration from video: Micro Air Vehicles, or MAVs, will play an important role in future warfare. The urban battlefield calls for tools to increase the warfighter's situational awareness and capacity to engage rapidly, precisely and with minimal collateral damage. MAVs will be integrated into future Air Force sensit systems. These systems may be airdropped or hand-launched, depending on the mission requirements. The small size of MAVs allows them to be hidden in plain sight. Once in place, an MAV can enter a low-powered extended surveillance mode for missions lasting days or weeks. This may require the MAV to harvest energy from environmental sources such as sunlight or wind, or from man-made sources such as power lines and vibrating machinery. It will blend in with its surroundings and operate undetected. MAVs will use micro-sensors and micro-processing technology to navigate and track targets through complicated terrain such as urban areas. Its small size and agile flight will enable MAVs to covertly enter locations inaccessible by traditional means of aerial surveillance. Multiple MAVs, each equipped with small sensors, will work together to survey a large area. The information from these sensors will be combined, providing the swarm of MAVs with a big picture point of view. Individual MAVs may perform direct attack missions and can be equipped with decapacitating chemicals, combustible payloads or even explosives for precision targeting capability. MAVs may carry sensors to detect chemical, biological or radiation threats and relay this information to human operators or other unmanned platforms. MAVs will become a vital element in the ever-changing warfighting environment and will help ensure success on the battlefield of the future. Unobtrusive. Pervasive. Lethal. Micro Air Vehicles, enhancing the capabilities of the future warfighter.]

And to provide you with one example of a Small Unmanned Aircraft System that is already being procured and is supporting our warfighters in the field, here's a short clip on the Battlefield

Air Targeting Micro Air Vehicle, or the BATMAV, capability. In this short clip, you can see the Air Force warfighters' ingress into the battle space carrying the BATMAVs with them. The BATMAV system is compact, weighs only 15 ounces, is easily set up and hand-launched, flies for 45 minutes, providing usable video to support warfighter mission accomplishments. And further improvements in its capability are underway with the latest required capabilities being provided to the warfighter this year. Again, this is but one example of Small Unmanned Aircraft Systems capabilities that are arming our warfighters with game-changing capabilities.

In addition to supporting combat ops, Unmanned Aircraft Systems also support contingency and peace operations. I'll cover several examples here.

- On May 18, 2006, the Federal Aviation Agency issued a certificate of authorization to enable Predator and Reaper use in United States' civil airspace to search for survivors during Hurricane Katrina relief operations.
- In 2007 a NASA variant of Reaper and the Global Hawk was used extensively to survey California wildfires and deploy firefighters to areas in highest need of disaster relief.
- UASs supported the customs and border patrol primary mission of securing borders and preventing acts of terrorism by providing persistent ISR to augment law enforcement aircraft, watercraft and agents. The customs and border patrol air and marine Unmanned Aircraft System support border surveillance ops, fugitive arrests, terrorist threats, illegal entry, drug seizures, etc.
- The Department of Homeland Security uses a Reaper variant in support of homeland security over the nation's land borders, Great Lakes region and in support of Department of Homeland Security's hurricane and flood ops. It's a powerful tool and force multiplier. It increased maritime domain awareness and confronted border threats.
- On March 25, 2009, Reaper flew CAPs over F-22 crash site to monitor and report on the situation and help provide crash site security.
- Air Force recently made history with an unarmed Predator when it took off from a Puerto Rican airport on January 27, 2010, to fly a surveillance mission over Haiti. This was the first use of Predator in support of humanitarian assistance operations and first time a remotely piloted aircraft operated from an active civilian airport. Predator continues flying a continuous orbit over Haiti to support international aid workers in reaching victims most in need.
- In addition to the significance of other contingency and peace operations, the Global Hawk has contributed capabilities too. It has also played a key role in the more recent Haiti humanitarian operations. The lower picture on this chart is an aerial view of the damaged Presidential Palace in Haiti taken by the Air Force Global Hawk aircraft on January 14, 2010. This and other Global Hawk aerial images have provided planners valuable situational awareness as they coordinated U.S. military support to the Haitian relief efforts.

Unmanned Aircraft Systems continue to make critical contributions to war and contingency/peace operations.

In my presentation, I've covered a lot of Unmanned Aircraft System advancements and progress, but there's also a flip-side to all of the positive efforts to deliver more UAS capabilities, one that goes well beyond the Air Force. You'll recall that I opened my remarks today by outlining how we are at the cusp of an information in war revolution. I spoke to how high the demand for information in war has grown and how Unmanned Aircraft Systems have quickly emerged to

meet that demand. We're fielding more and more sensors – collecting more and more data – and having to respond to an ever-increasing demand for information – all at a pace and volume that's been unparalleled. According to the Chief of Staff of the Air Force, in the not-too-distant future, we'll be swimming in sensors and drowning in the data. Accordingly, we need to apply the same level of effort to the tasking, processing and exploitation of data s we have to the endurance challenge of collecting it. Work has already begun to address this, but much more will be required.

The Air Force has defined a way ahead that makes the most of the payloads, platforms and opportunities that remotely piloted aircraft promise. That said, there's a cautionary note the Air Force is considering in its vision. At present in the U.S., we define our military challenges through the environments of regular, irregular, catastrophic and disruptive challenges, and apply our tools, like remotely piloted aircraft, to solving these challenges. These may be useful constructs of strategic environments, but these distinct characterizations of potential conflicts are intellectual bins that say more about us than our opponents, and they may lead us down the wrong road with respect to defense planning.

Consider the environment above Iraq and Afghanistan. It's permissive – one where we own the air and no one is attempting to take control of it from us. In parallel with the rapid expansion of technologies that are yielding advances in remotely operated systems, there are technologies that in the future will present us with contested or denied operating environments. It's in these contested or denied environments where our greatest challenges lie in designing remotely operated systems, platforms and payloads. In these environments, survivability emerges as a critical factor and one that we have yet to apply the full weight of our industry, thought and technology. You can, however, be assured that the Air Force is already working to address this, with the Air Force's Unmanned Aircraft Systems Flight Plan that I addressed previously, serving as a foundation guide for how we'll proceed. Industry and academia are already being invited to assist the Air Force.

OK, so let me wrap this up. We often hear of the asymmetric challenges our adversaries present us today. Let me remind you that the Air Force has asymmetrical advantages as well, and one of those is our ability to operate in the third dimension to a degree that our adversaries cannot directly affect. We know this because of what our opponents say. The top quote on this chart is dialog between two Taliban commanders … it didn't come from Air Force Public Affairs. The bottom quote is from a recent interview with a top Taliban commander. They're both testimony to the asymmetric advantage of our U.S. airpower and we'd be well-advised to consider strategies that allow us to better exploit this advantage.

I hope that my presentation has been informative and educational. My intent, as stated up front, was to let you know that the Air Force's UASs represent a capability that is changing many aspects of how the Air Force thinks about itself, and how we apply mass and economy of force in, through and from the air, both in war and in support of national crises. Unmanned Aircraft Systems bring attributes such as persistence, endurance, efficiency and connectivity that are proven force multipliers across the spectrum of global joint military ops. The 303rd Aeronautical Systems Wings here at the Aeronautical Systems Center, teamed with other DoD, industry and academia partners, is leading the way when it comes to acquiring these capabilities for our Air

Force customers.

With that, I'd like to leave you with just one last thought. From time to time, we'll get feedback on the values of our UAS systems to the war effort from the families of those troops that are deployed. Recently, Col. Daryl Houk, soon to be the 303rd Wing commander, relayed some of that type of feedback to me. During a recent interchange with a Dayton leadership group, he was greeted by a member of the group who identified herself just as an airborne mom. She relayed that her son was currently deployed and when she mentioned that she was coming to Wright-Patt for a visit during a telephone call with her son, he replied, "Mom, those are the folks keeping me safe with Predators overhead. Make sure you tell them thanks for me." She told this story to everyone she saw on base that day and has since also provided a written thanks to the ASC team. The UASs have become among the most critical weapon in the Air Force air arsenal, protecting the mothers, the fathers, the sons and daughters, to bring them home safely.