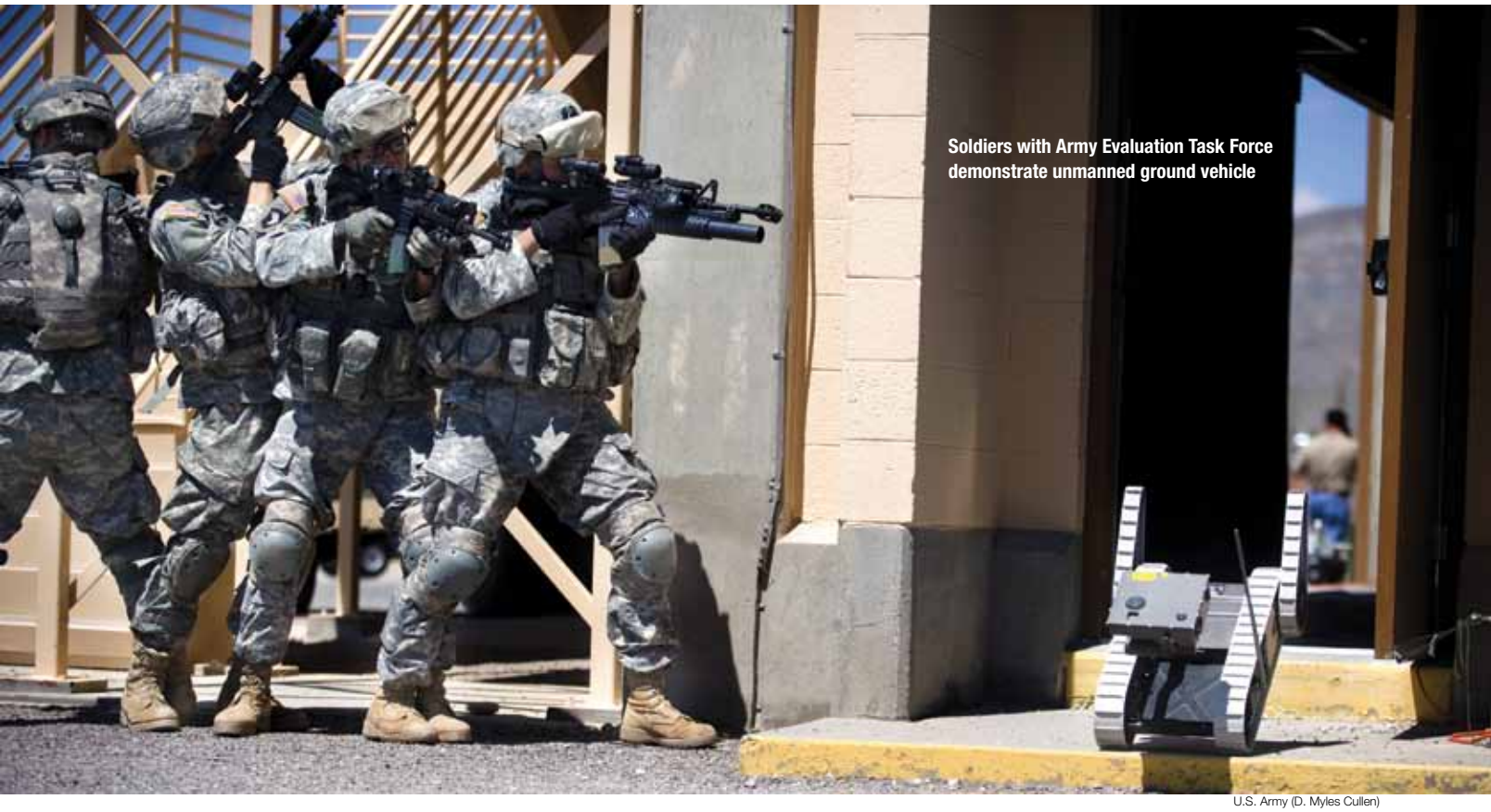

Soldiers with Army Evaluation Task Force demonstrate unmanned ground vehicle

U.S. Army (D. Myles Cullen)

Unmanned Systems AND THE Joint Team

By MICHAEL W. ISHERWOOD

There are those that see [Joint Strike Fighter] *as the last manned fighter. I'm one that's inclined to believe that.*[1]

—ADMIRAL MICHAEL G. MULLEN

Comments similar to the Chairman's statement can generate heated debate. Whether or not his inclination proves correct, the Department of Defense (DOD) is committing more than $18.9 billion to unmanned systems (UMS) development, procurement, and operations from 2009 to 2013, making it clear that unmanned capabilities are going to be an integral part of the future U.S. military.[2] Thus, force planners and warfighters will benefit from focusing on two things: first, on how UMS are contributing to contingency operations in U.S. Central Command (USCENTCOM) and other theaters of operation and how the systems can make joint operations more effective and efficient; and second, on solving the challenges facing future UMS development, allowing for enhanced integration and synchronization of the joint team.

This article explores these issues. It reinforces what UMS are accomplishing today while looking at them as a mechanism to forge new approaches to joint operations and force structure decisions.

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UMS Today

Unmanned systems are not new. Prior to World War II, the War Department used the OQ–2 "Radio Plane" to train Army and Navy antiaircraft gunners as it was not prudent for a pilot to fly within range of the novice gunners. In 1947 and 1948, the Air Force flew unmanned B–17s to collect radioactive materials after testing an atomic bomb.[3] During the Vietnam War, unmanned aircraft such as the Firebee relieved aircrews of the tedious and dangerous tasks of monitoring trail networks and locating surface-to-air missile sites. From these origins, unmanned systems became known for carrying out "dull, dangerous, and dirty" missions.

Today, UMS roles have expanded significantly. During the first 7 years of operations in Iraq and Afghanistan, unmanned aircraft systems (UAS) logged over 500,000 hours.[4] Air Force Lieutenant General Dave Deptula helped put UAS in perspective when he described the strike against Abu Musab al-Zarqawi, a leader of al Qaeda in Iraq. It took 6 minutes for a pair of F–16s to deliver the LGB–12,500 pound bomb, but *6,000 hours* of Predator time to track and pinpoint the target's location.[5] Today's UAS provide more than spot reconnaissance; they also contribute with wide area surveillance, target designation, full motion video, and weapons employment.

But UAS are not the sole UMS in the battlespace, as unmanned ground vehicles (UGVs) have conducted more than 30,000 missions in USCENTCOM during the same 7 years.[6] Ground systems focused on defeating and disarming improvised explosive devices, such as the ANDROS or the Manned Transportable Robotic System, provide most of the ground unmanned capability. Soldiers and Marines are expanding their inventory, however, with capabilities such as the Dragon Runner, a 17-pound device that clears routes and buildings or uncovers tripwire traps. There is also the Mobile Detection, Assessment, and Response System, which augments base security details with continuous surveillance with semi-automated random patrols.[7] These are a few of the more than 6,000 UGVs fielded by the Services since 2001.[8]

The impetus to increase UMS contributions comes from a variety of sources. One has been the change of the operational environment and the expansion of the number of missions. In 1975, for example, U.S. forces were deployed to support the "1½ War Strategy" and prepared for military operations in northern central Europe and northeast Asia. More than 2.1 million Americans in uniform supported this readiness.

U.S. Forces are now engaged in combat in Iraq, Afghanistan, and the Horn of Africa in addition to being deployed in dozens of operations around the world. Despite this higher operational tempo, the number of troops has declined to 1.4 million. The personnel cost of the all-volunteer force has increased 45 percent in the past 10 years, placing DOD under pressure to reduce manpower costs while making personnel in uniform more effective.[9]

Enabling fewer people to accomplish a mission is not new for the U.S. Armed Forces. During the early days of the Cold War, force planners sought a more cost-efficient means to provide for a nuclear force. The result was the strategic triad—nuclear bombers, intercontinental ballistic missiles, and submarine-launched ballistic missiles. The investments in ballistic missiles allowed a reduced bomber contingent and cut nuclear force operations and maintenance costs by 46 percent from 1969 to 1979. At the same time, the nuclear force's survivability increased, adding to its deterrent value while a number of KC–135 air refueling aircraft were freed up for conventional missions.

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Appreciating the value of UMS to current and future conventional campaigns allows force planners and warfighters to realize the potential to extend UMS contributions into adjacent military operations. Three illustrative scenarios help define the considerable benefits of UMS in the near future.

Anti-piracy Operations

When integrated with land, sea, and air forces within a component, unmanned systems can enable the entire joint team to be more effective. One scenario highlighting this potential involves deploying maritime forces to deter piracy in the waters off the coast of Somalia.

The maritime component commander's immediate challenge will be to gain awareness 200 miles east from Somalia and in the neighboring Gulf of Aden—an area of more than 480,000 square miles. If tasked for this mission today, a maritime combined task force (CTF) might include 20 destroyer-sized vessels, each with 300 Sailors and outfitted with an SH–60 helicopter.[10] A P–3 Orion detachment would support the mission and focus its surveillance and reconnaissance efforts in a high traffic area waterway while SH–60s could surveil an area out to 50 miles from their ships. At any given time, the task force could monitor 91,000 square miles.

Integrating maritime high altitude long endurance (HALE) and medium altitude long endurance (MALE) intelligence, surveillance, and reconnaissance (ISR) UAS with surface ships could enable the CTF to cover the entire area with fewer forces. A single HALE orbit at 60,000 feet could cover over 300,000

U.S. Army (Yuma Proving Ground Public Affairs Office)

Future unmanned ground vehicles must have ability to adjust to terrain features and environment changes

U.S. Southern Command

Aerial images such as this Global Hawk photo of Haiti earthquake damage provide commanders with situational awareness

square miles with signals intelligence collection. Simultaneously, its onboard moving target indicator radar could detect vessels at a shorter range. When these data are fused with information from its Automatic Information System, which tracks cooperating commercial vessels, maritime commanders could discriminate legitimate commercial vessels from possible pirate ships.

Once a suspect vessel is detected, the commander could monitor that ship with the HALE or MALE UAS. A rotary-winged MALE UAS could be positioned within visual range of a suspect ship in a deterrent posture, giving the CTF additional options. If the suspect vessel functioned as a pirate "mother ship" and deployed smaller boarding boats, the MALE UAS could employ warning or disabling fire as a further deterrent. If physical intervention is required, UAS information could guide the SH–60 as it inserted and extracted personnel. Thus, the CTF, with integrated manned and unmanned maritime units, could gain greater situational awareness of ships moving throughout its area of operation. Armed with timely information, the CTF commander could be better postured to apply force in an effective manner.

In addition to increased mission effectiveness, the UAS force could allow the CTF to be more efficient. Three HALE and three MALE orbits, when combined with seven surface vessels, could provide the ability to surveil the entire area of operations. Sustaining three UAS orbits would require six to seven airframes. CTF flight operations costs would decrease from $7 million to approximately $1.7 million per day. The CTF would realize a corresponding decrease in ships, Sailors, and associated operations costs as well.

Protecting U.S. Borders

There is potential to integrate land, sea, and air UMS to support missions that may be beyond the resources of the current joint force. One example is employing UAS and unmanned undersea vehicle (UUV) forces in a cooperative manner to help U.S. Northern Command monitor coastal waterways and detect semisubmersible vessels.

Operating a few feet below the surface, a semisubmersible vessel is often used by drug cartels to infiltrate contraband into the United States and is difficult to detect by aircraft. UUVs equipped with sensors and deployed in a "picket line" formation can detect the movement or engine noise from the submersible. Once alerted, the UUV formation can triangulate an approximate location while maritime authorities direct a HALE or MALE UAS to search the surface area. If the disturbance is on the surface, the UAS electro-optical (EO) and infrared (IR) imagery or radar sensors can classify it and monitor it if warranted. If nothing is observed on the surface, a semisubmersible is present, and a U.S. Navy or Coast Guard vessel could be directed to the area to collect further information and intercept the vessel.

The costs associated with accomplishing this mission with current manned forces would be significant. The least expensive option would be to use maritime helicopters with a towed sonar array. The MH–53 could operate for 2 to 2½ hours, but its speed is limited to 20 knots when the array is deployed. As a result, 10 to 12 sorties would be required to cover a 100-nautical-mile line over a 24-hour period with the helicopter making five passes along that line. In other words, the sensor would not be continuously present. The flight operations and maintenance cost would be at least $400,000 per day.

In contrast, three UUVs could monitor the same 100-nautical-mile line *continuously* at a cost of roughly $70,000 per day. The unmanned capability would provide the sustained surveillance while the manned helicopter (or ship) provides the intercept capability. This pairing of manned and unmanned capability reflects the potential for the joint force to operate more effectively and efficiently.

U.S. Navy (Tiffini Jones Vanderwyst)

Chief of Naval Operations ADM Roughead drives semisubmersible boat seized from drug smugglers in Caribbean

Support to Humanitarian Operations

A final example of how UMS can extend the capability of the joint force is seen in humanitarian and disaster relief operations. Often, such operations occur in areas where U.S. forces are not deployed, thrusting commanders into a situational awareness vacuum. During support for peacekeeping operations in Liberia (2003), the Indonesian tsunami (2004), or the Pakistan earthquake (2005), the joint force was tasked for an immediate response but lacked prior knowledge of the country's infrastructure, people, or military forces and their disposition.

ISR forces are often first on scene to collect data that commanders need for these short-notice operations, such as survivor locations; status of bridges, roads, waterways, and dikes; geospatial data; and other time-critical

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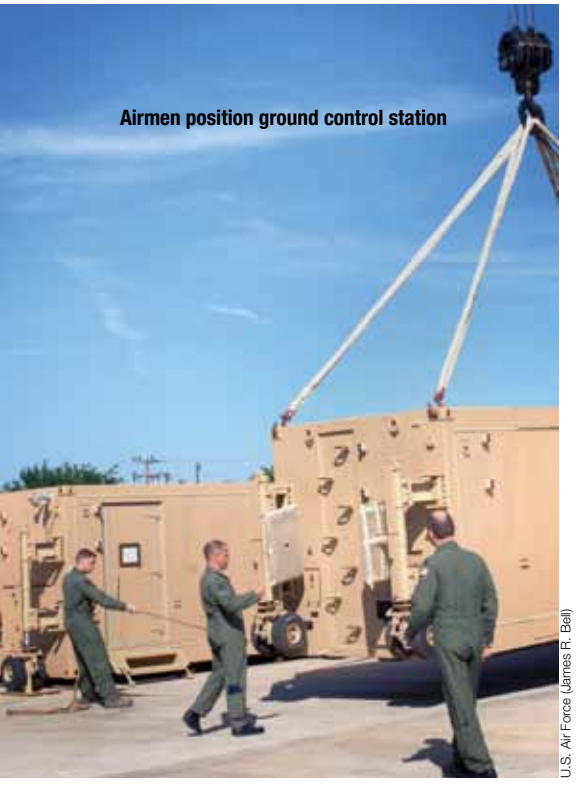
information. The air component's ISR inventory offers a flexible and responsive tool for such contingencies. To appreciate how unmanned ISR systems can improve the joint team's mission effectiveness, consider a situation where U.S. forces are called to support humanitarian aid delivery into Darfur in West Africa.

One of the mainstays of the air component's ISR inventory has been the U–2 sensor suite, which collects signal information while also providing EO and IR imagery. Human limitations, however, constrain the aircraft's sortie length to 9–12 hours. If launched from a North Atlantic Treaty Organization (NATO) base in southern Italy, the U–2 could transit the 1,900 miles to the region and have 3 hours time on station (TOS). During each sortie, the U–2 could map 3 percent of the region.

By comparison, a HALE UAS such as Global Hawk could provide the same type of information but with greater TOS. The airframe has the ability to remain airborne in excess of 32 hours. During its extended TOS, a HALE UAS could map over 50 percent of the region.

In addition to improved mission effectiveness, UAS offer force structure efficiencies. For instance, while supporting NATO operations in Kosovo, the Air Force deployed 5 U–2s and 175 Airmen. If committed to support Darfur operations, those U–2s could provide a maximum of 15 hours per day of coverage. By comparison, two Global Hawks, supported by 35 deployed personnel, could ensure continuous coverage.



Airmen position ground control station

U.S. Air Force (James R. Bell)

Future Challenges

Integrating UMS into the joint force, thereby making joint operations more effective and efficient, requires recognizing and overcoming a number of challenges. Three key areas stand out: command and control, sense and avoid, and joint procurement.

Command and Control. The need for a common mission management system or ground control station (GCS) drives the need for better command and control of unmanned systems. Currently, each UMS has a unique GCS, increasing the procurement cost and requiring specialized training for its operators. One of a kind GCS also requires individual integration into the joint force command and control network.

future common ground control stations should take human factors engineering into account

To overcome these problems, the DOD acquisition chief in February 2009 directed the Services to pursue common GCS with open architecture that allows for rapid innovation, fewer complications when integrating with theater operations, and improved training.[11] This is a logical step. For UAS, as an example, the GCS is the equivalent of the "cockpit" for the aircrew. Today, manned aircraft share certain common components. For example, human factors engineering has produced aircraft with gear handles of the same shape and size, radios that function in similar manners with common switches, and common heads-up information displays. In addition to promoting more efficient training, common cockpit designs promote flight safety by not requiring pilots to relearn basic crew-aircraft interface and habit patterns.

Future common GCS should also take human factors engineering into account. Unmanned vehicles will have certain tasks common to each vehicle. To the maximum extent possible, GCS must capitalize on the proven technical solution for such basic tasks. As a result, scarce research and development funds can be dedicated to unique UMS mission capabilities.

Sense and Avoid. A second area for improvement across all domains is in UMS ability to sense and avoid obstacles and objects in their environment. For UAS, the primary consideration is avoiding other aircraft. Currently, when operating in U.S. airspace, pilots follow a "see and avoid" mandate with other aircraft. The challenge is to develop advanced Traffic Collision Avoidance Systems that have the highest degree of confidence for aircraft deconfliction, whether the other aircraft is manned or whether its transponder is emitting.[12]

Avoidance for UAS includes surviving advanced air defense threats. UAS operate in a permissive environment, but future joint operations may require them to penetrate denied airspace, necessitating improved vehicle survivability. Maneuverability has often been one of the aircraft's attributes to enhance its survivability, and the unmanned vehicle will not be limited by the 9G human performance boundary that restricts current fighter aircraft employment. Unmanned aircraft capable of sustaining 20, 30, or even 40G maneuvers are conceivable but will require new technologies.[13]

Sense and avoid capabilities for future UGVs will be more complex. If the maritime and air environments are relatively homogenous, the land domain has more intricate obstacles, as UGVs must navigate ditches, curbs, shrubs, collapsed bridges, downed trees, and power lines, as well as injured and immobile personnel. UGVs must also have the ability to adjust autonomously to changes in the environment. While operating on clear roads or fields in the morning, the unmanned ground vehicle could then have to contend with snow, ice, or mud suddenly as weather alters ground conditions. This requires future unmanned ground vehicles to detect, classify, and assess their maneuverability around wider ranges of situations.[14] In addition, the land environment has more moving obstacles than the corresponding maritime or air domains.

Sense and avoid technologies permitting operations in these environments will also enable autonomous or semiautonomous operations underground, in bunkers, or in buildings where the UGV cannot receive Global Positioning System (GPS) signals for navigation, requiring advanced intelligence visual navigation. An unmanned ground vehicle will also require a means to protect itself from tampering when it operates within a population.[15]

The maritime domain has distinct challenges as well. More robust propulsion systems are necessary for sustained speed and distance, but today's UUVs rely on limited battery power. Future generations will need

improved power sources to gain the range and speed required for these vehicles to have a greater role in the joint team.

Joint Acquisition. The final key challenge in UMS is the willingness of the Services to view unmanned systems acquisition as an opportunity to improve joint acquisition. With the manipulation of sensors and exploitation of data removed from the air vehicle, UMS procurement can allow for greater commonality and interoperability of the vehicle. This potential is evident with the Air Force Global Hawk and Navy Broad Area Maritime Surveillance air systems, where 68 percent of the air vehicles share common components.

This is a logical step. Within the Air Force, for example, UAS have evolved from the Predator as an EO/IR and full-motion video sensor platform to the Reaper, incorporating a variety of weapons: Hellfire missiles, GBU–12 laser-guided bombs, GBU–38 GPS-aided bombs, and the AIM–9 air-to-air missile. In this manner, the Reaper has broken barriers between the Air Force mission areas of ISR, close air support, and air superiority.

As force planners and acquisition authorities look to the next generation of air combat vehicles, UMS offer the chance to further overcome artificial barriers between joint mission areas and Service acquisition programs. For instance, what are the opportunities with the Navy's unmanned combat air system, the Air Force's Next Generation Bomber, and a future ISR and command and control platform? Recognizing joint UMS as an opportunity to field more interoperable weapons systems would allow acquisition communities to accentuate the commonality of the capabilities.

Thus, rather than discuss whether the F–35 is the last manned aircraft, an alternative mindset would be to approach the next air vehicle the Services acquire as the first joint combat air vehicle—where up to 90 percent of the components might be common to all Services' vehicles.

UMS must overcome more cultural than technical barriers to capitalize on these opportunities. Perhaps the greatest challenge will be creating a culture that accepts unmanned capability and respects those who operate it. Progress can be made in this area when all realize that unmanned systems will not remove the Soldier, Sailor, Marine, or Airman from combat. Retired Air Force Lieutenant General Dan Leaf predicts that in the future, we will have "a mix of manned and unmanned platforms that ensures we will have a human stake in the lethal business of war."[16]

The unmanned system contribution to the joint force is increasing as these systems are no longer niche capabilities used for dull, dangerous, or dirty missions, as the radio plane or unmanned bomber were in the 1940s. Integrating UMS into the joint force allows them to accomplish more missions with greater savings of scarce resources, such as dollars and personnel. In the future, joint command and control, sense and avoid, and acquisition programs will increase the value of UMS to the joint team. Improved effectiveness and efficiency are possible only when viewed as integral with and complementary to the joint force. **JFQ**

NOTES

[1] John T. Bennett, "Last Manned U.S. Tactical Plane? Not Yet," *Defense News*, December 7, 2009.

[2] Office of the Secretary of Defense (OSD), *FY2009–2037 Unmanned Systems Integrated Roadmap*, April 2009, 4.

[3] OSD, *Unmanned Systems Roadmap: 2007–2032*, December 10, 2007, 19.

[4] OSD, *FY2009–2037*, xiii.

[5] Interview of Lieutenant General David Deptula, USAF, in *Defense News*, January 12, 2009, available at <www.defensenews.com/story.php?i=3896251>.

[6] OSD, *FY2009–2037*, xiii.

[7] Ibid., 119, 121, 125, 133.

[8] Ibid., 3.

[9] "Cost of the Force," *Air Force Magazine*, April 2009, available at <www.airforce-magazine.com/MagazineArchive/Pages/2009/April%202009/0409cost.aspx>.

[10] For analysis purposes, a flotilla of 20 ships could be expected to have 5 ships in port/off-station on any given day.

[11] OSD, Acquisition, Technology, and Logistics Memorandum, "Unmanned Aircraft Systems (UAS) Ground Control Station (GCS) Acquisition Decision Memorandum (ADM)," February 11, 2009.

[12] OSD, *FY2009–2037*, 29.

[13] Ibid., 29.

[14] Ibid.

[15] Ibid., 3, 49.

[16] Author interview of Lieutenant General Dan Leaf, USAF (Ret.), September 23, 2009.