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The Future of Unmanned Systems in Cavalry Squadrons

by CPT Christopher M. Brandt

The future of reconnaissance-and-security tactics lies in our ability to effectively combine manned assets with unmanned systems, a concept known as manned-to-unmanned teaming. To meet the demands of 2025 and beyond, our Cavalry squadrons must acquire and incorporate the capabilities of unmanned systems into our formations. This article will discuss the case for miniaturized unmanned systems, their potential tactical capabilities for reconnaissance-and-security operations, the current state of the technology and expected limitations and future research of the systems.

Imagine a reconnaissance team quietly infiltrating a wooded area. It is dark outside; the moon has yet to rise over the horizon. The scouts know of their enemy's night-vision and large-platform unmanned aerial vehicle (UAV) intelligence, surveillance and reconnaissance (ISR) capabilities, so they remain concealed in the trees. As they near a clearing, the team stops and begins to set in security. One of them removes a small container out of a pouch on his vest and, a minute later, he has set up a tiny helicopter smaller than the size of his hand. The helicopter's blades begin to spin, and it hovers in the air next to the scout. It is so small that its sound is almost inaudible, and as it flies up above the tree line, it is virtually undetectable. The scout watches a thermal video feed from the miniature helicopter as it flies above the tree line, guided along its planned route by Global Positioning System (GPS) signal.

A few minutes into the flight, he has located enemy vehicles and personnel in a defensive position about a kilometer away. At the press of a button, the drone lazes the target, and it delivers a triangulated set of coordinates to the enemy position. The team leader radios the coordinates back to his headquarters, requesting a fire mission for this target of opportunity. Moments later, artillery begins raining down on the unsuspecting troops. The team leader calls in corrections based on feedback from his video feed. As the fire mission successfully ends, the drone returns to the team. They quickly recover it and prepare to move, safely out of their disarrayed enemy's sight.

Now, imagine the victims in this stealthy attack are U.S. troops under attack from a near-peer threat.

Although the reconnaissance team pictured in the preceding scenario is from a conventional state threat, it is easy to conceive of an unconventional force using existing commercial items to create similar capability sets. Commercial off-the-shelf products are consistently increasing in popularity and availability, and many already have GPS navigation and video-recording capabilities.[1] It would not be difficult for violent non-state actors to create aerial improvised explosive devices ("suicide drones") by loading small amounts of explosives onto a small or micro unmanned aerial system (UAS) and remotely piloting the system to a point of detonation.[2] A scenario such as this one is becoming increasingly likely as the miniaturization and proliferation of technology makes it easier for militaries and violent non-state actors to acquire similar technology.

The political world is beginning to adjust to this paradigm shift, and it will soon become increasingly important for our military forces to meet or exceed the pace of other nations' unmanned research and development.

Why unmanned systems?

It is unlikely that today's generals spent much time when they were second lieutenants thinking about things such as the Internet, cellphones or social media. Despite this, technological revolutions like these have changed the landscape of the strategic, operational and tactical levels of warfare. Unmanned systems are another technological advancement that has indelibly impacted the way we fight. As the Defense Department's ***Unmanned Systems Integrated Roadmap FY2013-2038*** states, "The prevalence and uses of unmanned systems continue to grow at a dramatic pace. The past decade of conflict has seen the greatest increase in unmanned aircraft systems, primarily performing ISR missions."[3]

When asking ourselves why we should consider unmanned systems, there are several key reasons. Chief among these is the tactical benefit. In Iraq and Afghanistan, small UAS (SUAS) such as the Puma and Raven have already proven incredibly useful in providing more situational awareness to troop-level commanders.[4] However, current systems often filter data from ISR platforms through multiple levels of command, increasing reaction and response time. Even troop systems such as the Puma, Raven and the One-System Remote Video Terminal are not always accessible to the Soldier in the field. Enabling ISR capability at the section or platoon level will result in faster *observe, orient, decide* and *act* decision cycles, leading to an increase in enemy acquisition and decreases in small-unit response times.

Another important consideration is the relative reduction in enemy detection of our forces. By being able to remotely pilot unmanned systems, scouts have an enabler that will assist them in remaining undetected. Furthermore, the smaller acoustic and radar signatures make detection of the unmanned system much less likely.[5] This will ultimately save the lives of our Soldiers.

Finally, one more benefit is the comparable cost-savings of developing small unmanned systems for use when compared to large systems like the MQ-1 Predator and MQ-9 Reaper.[6] The unmanned systems themselves are relatively inexpensive to produce, and their prices will continue to drop as mass production increases.[7] By using common sensors and interchangeable parts, the U.S. military can "capitalize on commonality, standardization and joint acquisition" to "create unmanned systems that are both effective and affordable."[8]

Tactical capabilities

There are many theoretical applications of future unmanned air and ground systems.[9] These come in the form of "payloads," or interchangeable modules that provide specific capability sets. Many of these capabilities support key tasks for a Cavalry squadron. Based on the following proposed capabilities, unmanned systems could have a significant impact on the way we fight wars in the near future:

- Electro-optical/infrared sensors provide live video feeds in day or night scenarios.
- Target-locator modules provide target acquisition capability for artillery and air strikes.
- A communications module provides additional radio or retransmission capability ideal for extended-range communications.
- A data-networking module to support cueing other ground and air reconnaissance assets links these systems to focus collection on the target.
- An electronic-warfare (EW) module would support collection or disruption of signals.
- Chemical, biological, radioactive and nuclear (CBRN) modules would support early warning and reporting of "dirty" environments while keeping Soldiers at a safe distance.[10] [11]
- Unmanned systems in a "perch-and-stare" mode (placed in a low-power-consumption stationary setting) would use passive acoustic, magnetic, seismic and visual sensors to provide early warning during security operations.
- Accurate aerial three-dimensional photomapping provides near real-time area or route reconnaissance intelligence.[12]
- Offensive or defensive capabilities could be developed such as small arms,[13] [14] fragmentary grenades, bombs or rocket capabilities.[15] [16]
- Ground- or air-based resupply vehicles could help to deliver vital supplies or ammunition to scouts ahead of the main body without putting support personnel in danger.[17]
- Ground-based unmanned engineering vehicles could be used to breach obstacles or dig fighting positions.[18]

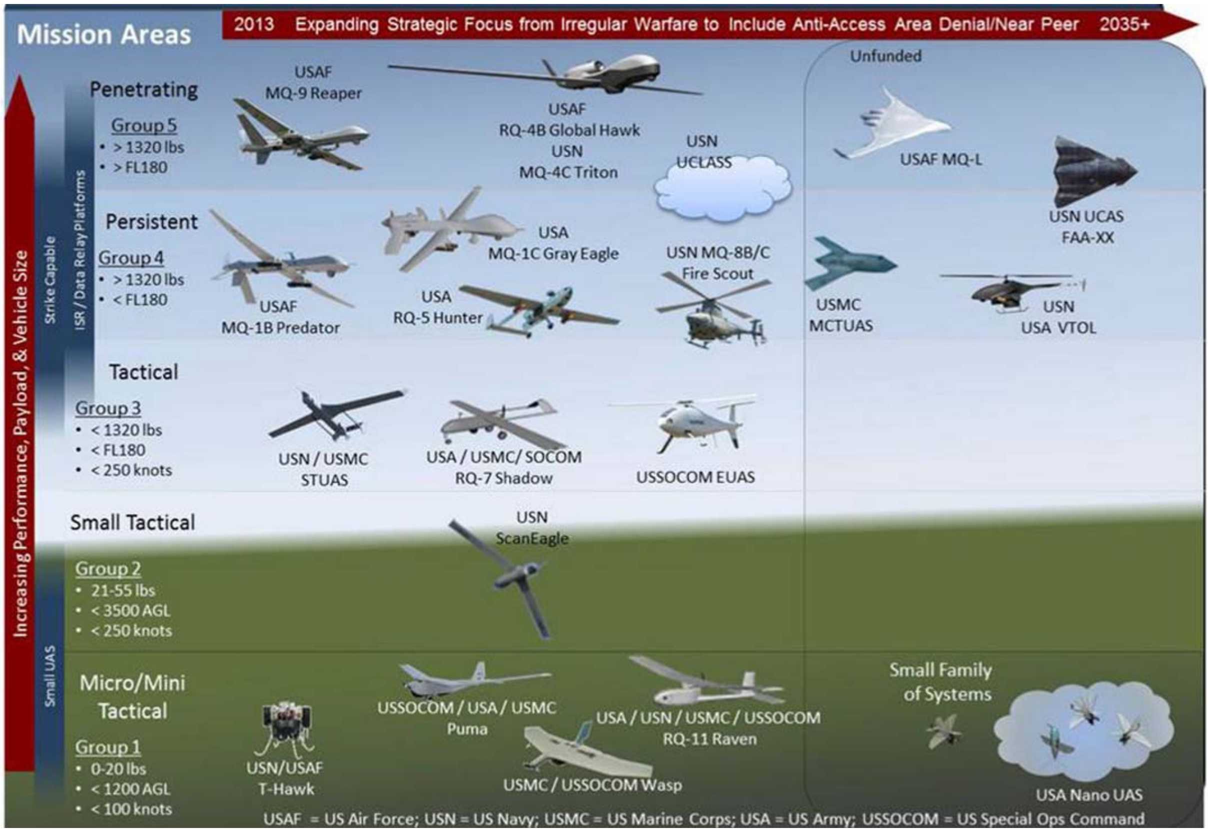

Figure 1. DoD unmanned systems roadmap for UAS (FY 13-38).

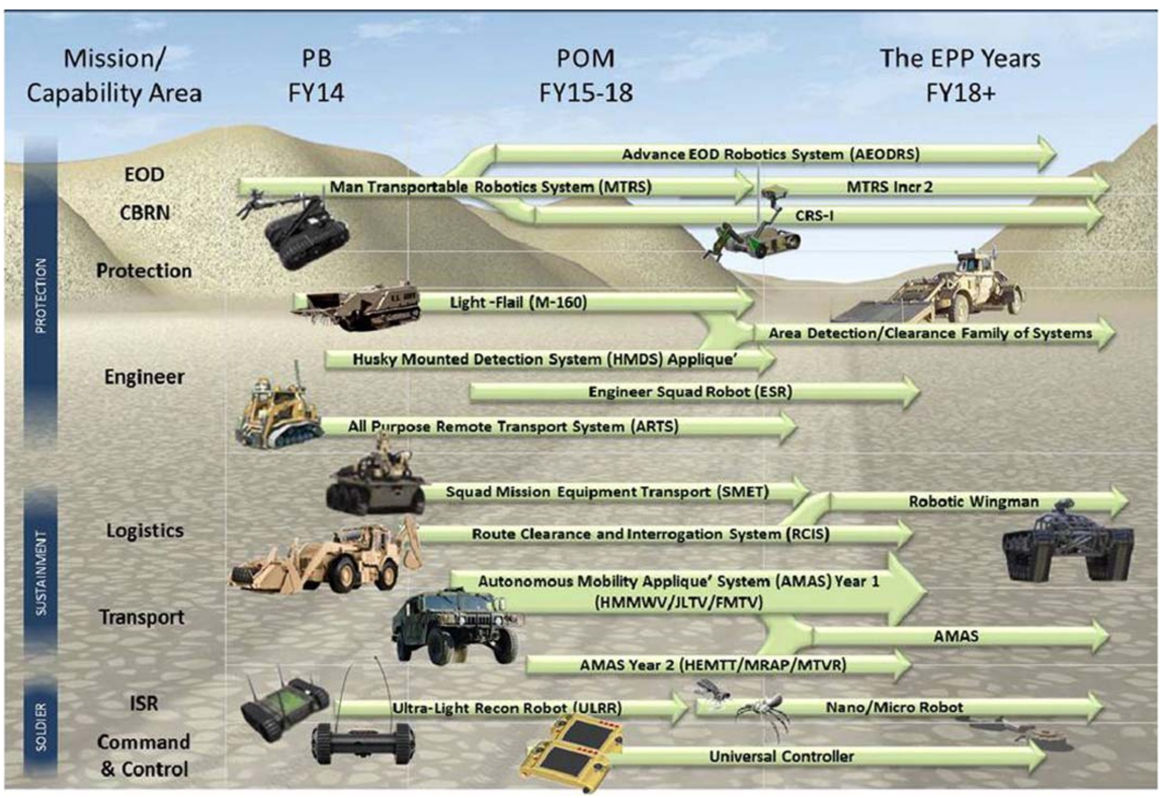

Figure 2. DoD unmanned systems roadmap for UGS (FY 13-38).

Current technology

There are many commercial systems already available from companies who are leading the way in this new field. However, the current price range for most of these systems mean that they will primarily be used in business, government, military and research applications. For hobbyists, there are simplistic systems available. In general, the prices are decreasing and will continue to do so over the next decade.[19]

The U.S. Army currently uses small UAVs (SUAVs). These include systems such as AeroVironment's RQ-11 Raven, RQ-20 Puma, the less-common Wasp III and the Switchblade Lethal Miniature Aerial Munition System. SUAVs are typically hand- or rail-launched and can be either man- or vehicle-portable. Their increased size allows for more robust sensor packages and the possibility of weapons or other munitions to be attached. These larger systems would most likely remain primarily troop assets.

Micro aerial vehicles (MAVs) are smaller than SUAS and can generally be carried in an assault pack or rucksack. These vehicles include common commercial rotary configurations such as quadrotor helicopters. When launched, they have a range of five to 15 kilometers, a typical maximum takeoff weight (MTOW) of five kilograms and an average flight duration of one to two hours, depending on the payload and other factors.[20] MAVs have a significant advantage over SUAVs in their size and portability, and advantages over nano aerial vehicles (NAVs) in their duration, payload and operational range. Their typical five kilograms (11 pounds) MTOW allows many configurations of sensor modules. Examples of these include Aeryon's Scout, PSI Tactical's InstantEye and AeroVironment's Shrike. These would likely be a platoon asset. Their versatility would allow a platoon leader the freedom to use this enabler based on the requirements of his mission.

NAVs are smaller than MAVs. They could be transported in a container the size of a pouch, would have an operational range of one kilometer or less, a MTOW of 25 grams and a maximum flight time of an hour or less. NAVs give the most expedient feedback to the end user and require the least setup. Their limited capabilities best serve lower echelons such as teams and sections/squads. One example is the AeroVironment Hummingbird, which is designed to resemble and fly like a hummingbird.

A few other examples of these already exist, but the best known is the PD-100 Black Hornet, developed by Prox Dynamics. The PD-100 has already been in use in Afghanistan for several years, and feedback from the field has been positive.[21] The U.S. Army Natick Soldier Research, Development and Engineering Center (NSRDEC) recently selected the PD-100 to be its base model for the future Cargo Pocket ISR Program.

Figure 3. PD-100 Black Hornet. ***(Photo by SGT Rupert Frere. United Kingdom Crown Copyright. Used by permission)***

“The Cargo Pocket ISR is a true example of an applied-systems approach for developing new Soldier capabilities,” said Dr. Laurel Allender, acting NSRDEC technical director. “It provides an integrated capability for the Soldier and small unit for increased situational awareness and understanding with negligible impact on Soldier load and agility.”[22]

NAVs would best serve as section assets, where short-range tactical ISR is most necessary. For example, Soldiers manning an observation post could use NAVs to regularly supplement their patrolling capabilities.

Unmanned ground vehicles (UGVs) include wheeled, tracked or bipedal/quadruped vehicles of varying sizes and capabilities. The U.S. military currently uses several of these types of vehicles, including the Talon bomb disposal and Special Weapons Observation Reconnaissance Detection System tactical robots. Other nations have already developed UGVs for the purpose of battlefield surveillance, route clearance, breaching and resupply operations. Israel is now employing the Loyal Partner and Guardium UGVs, both tactical vehicles outfitted with sensors and capable of performing resupply operations.[23] In the United States, the Defense Advanced Research Projects Agency recently tested the AlphaDog Legged Squad-Support System, a robot pack mule capable of carrying 400 pounds of equipment or supplies for a distance of 20 miles to support dismounted Marines.[24] Meanwhile, the United Kingdom recently acquired the Terrier UGV, an excavating vehicle designed to breach obstacles or perform engineering functions.[25]

While large UGVs have the advantage of being able to carry more equipment and sensors, they also have the disadvantage of being large targets, making them easier to detect. As the technology behind the UGV improves, smaller vehicles may emerge similar in scale and capability to MAVs and NAVs. An example of this is the Raptor, a small biped robot capable of running 46 kilometers an hour and climbing over obstacles 100 millimeters high.[26] Another example is the Cobra MK2, a mini wheeled UGV by ECA Robotics used by the French army in Afghanistan, which is capable of outfitting various modules to meet mission requirements.[27]

Limitations and future research

The current capabilities of unmanned systems are degraded by several significant limitations.[28] These limitations are generally the focal point for current research, which will lead to the next generation of smaller and more capable systems.

Most significant among these is power for the systems.[29] Power solutions like engines or batteries require valuable weight, which significantly affects MAVs and NAVs. Power solutions such as hybrid power or fuel cells have been proposed and examined to overcome these challenges.[30]

The power discussion is often coupled with the weight problem. MAVs and NAVs have very specific payload requirements to maintain their capabilities. Even as miniaturization continues to make improvements to the technology, ensuring the vehicle meets its weight requirements will likely continue to be a limiting factor.

EW will be a challenge for remotely operating vehicles. Many unmanned systems operate along preprogrammed routes or are able to automatically return to a designated point in case of emergency or loss of signal. As new techniques for avoiding enemy EW are devised, it is likely that the enemy will also adjust its jamming capabilities to match.

Wind has a much more significant impact on MAVs and NAVs than SUAS or larger aircraft. Furthermore, it has a more of an impact on rotary-wing systems than fixed-wing systems.[31] “As you scale down, the air becomes thicker, basically, and it becomes much more of a challenge in terms of aerodynamic surfaces,” according to Dr. Stephen Prior. “The degree of complexity is multiplied.”[32]

Despite this, some researchers are rising to the challenge by imitating the capabilities of insects such as bees, flies and moths. The InstantEye, offered by PSI tactical, is designed as an all-weather MAV. It is capable of maintaining a video-feed lock on a ground target in 55 mph winds due to its ability to quickly recover from unexpected shifts in forces (i.e., a strong gust of wind or a collision).[33]

Figure 4. PSI's Tactical InstantEye.

Miniaturization has its limitations. Some needed sensors may not be possible to scale down to NAV-size sensor platforms. In this case, it will be necessary to maintain both NAVs and MAVs until new breakthroughs can allow for further scaling down.[34]

The equipment is only as good as the Soldier. Good training will be essential to ensure that operators understand the capabilities and limitations of their systems before employing them.

Collision-avoidance capability is the next necessary technological requirement for MAVs, NAVs and UGVs.[35] Giving the unmanned system the autonomy to autocorrect course deviations or avoid objects will be necessary to reduce the impact of human error. Future NAVs would likely include smaller insect-sized vehicles, possibly capable of "swarming" an area to provide more abilities and feedback.[36] Collision-avoidance capability will be imperative to ensure the vehicles do not hit each other.

Conclusions

The possible tactical applications of unmanned systems to Cavalry squadrons are myriad as described by some of the proposed capability sets. They would fulfill or augment many of the Cavalry squadron's critical support roles as defined in the "2014 Cavalry Squadron Capability Review" whitepaper:[37]

- Improved ISR and CBRN payloads allow the squadron (and subsequently the brigade) to better identify opportunities and dangers, develop the situation in contact, determine enemy intent and provide time and space.
- More communications or reconnaissance capabilities will help facilitate transition to the brigade's main body or to one of the infantry battalions.
- Lastly, targeting, communications and offensive payloads enable the discriminate use of force. In turn, this can ensure freedom of maneuver and action, or create and preserve options for the brigade combat team (BCT) commander.

The future tactical benefits will outweigh the short-term research-and-production costs. The benefits of remote capabilities have already been demonstrated in Iraq and Afghanistan, resulting in a reduction in risk and Soldiers' lives lost. It has also resulted in improvements to the ground commander's situational awareness and faster decision cycles. Bringing unmanned systems to lower echelons will continue to increase their capability to successfully conduct reconnaissance-and-security operations. Technology that is currently available already supports this vision. Limitations to these systems can and will be overcome in time.

Unmanned systems are here to stay. Much like the rise of the cellphone, their prevalence on the battlefield will only increase as the technology proliferates and production costs decrease. As the next generations of unmanned systems evolve, they have the potential to change the way we think about warfare. It is in our best interest to get involved and shape the tactics that will make us successful in 2025 and beyond, instead of reacting to contact once the threat is here.

CPT Chris Brandt is the troop commander for Headquarters and Headquarters Troop, 3-89 Cavalry at Fort Polk, LA. His past assignments include commander, Troop A, 3-89 Cavalry; brigade planner, 4th BCT, 10th Mountain Division; executive officer, Company C, 2-8 Cavalry; assistant S-3, 2-8 Cavalry; and platoon leader, Company D, 2-8 Cavalry. CPT Brandt's military schooling includes Armor Officer Basic Course, Maneuver Captain's Career Course, Infantry Mortar Leader's Course and Cavalry Leader's Course. He holds a bachelor's of arts degree in philosophy from Texas A&M University.

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Acronym Quick-Scan

BCT – brigade combat team
CBRN – chemical, biological, radioactive and nuclear
EW – electronic warfare
GPS – Global Positioning System
ISR – intelligence, surveillance and reconnaissance
MAV – micro aerial vehicle
MTOW – maximum takeoff weight
NAV – nano aerial vehicle
NSRDEC – Natick Soldier Research, Development and Engineering Center
SUAS – small unmanned aerial system
SUAV – small unmanned aerial vehicle
UAS – unmanned aerial system
UAV – unmanned aerial vehicle
UGV – unmanned ground vehicle