Implementing Quadcopter Unmanned Aerial Systems into Reconnaissance Platoons

by SGT Christopher Broman

During the past 18-plus years of conflict in the global war on terrorism, the U.S. military has witnessed the effectiveness of unmanned aerial systems (UASs) in a variety of mission sets. In the beginning, these systems were large and expensive, which initially allocated them to the role of theater-level or battlespace assets. As the years have progressed, miniaturization has allowed these assets to filter down to the squadron and troop levels with systems such as the RQ-11 Raven.[1] As mass production increases and their uses expand, these systems are becoming both smaller and relatively inexpensive to produce.[2] As a result, between 2004 and 2008, the number of UAS deployed globally increased from around 1,000 to 5,000 systems.[3]

This widespread availability has been demonstrated best not by near-peer threats but by non-state actors such as the Islamic State in Iraq and Syria (ISIS). During the battle for Mosul, ISIS flew more than 300 missions in one month, using off-the-shelf drones that cost as little as $650, mainly quadcopters.[4] Of those missions, about 1/3 were armed strikes, with the remaining missions being intelligence, surveillance and reconnaissance (ISR).[5] This demonstrated both the ready availability of these assets and their effectiveness, especially in urban settings. Despite this, most U.S. troop-sized elements still have only one UAS asset readily available: the RQ-11 Raven system. Instead, each cavalry troop should be operating two quadcopter drone systems per platoon in addition to having the Raven.

Why platoon level?

The use of UAS at platoon level is not an unknown concept in reconnaissance operations. Both Field Manual Interim (FMI) 3-04.155, ***Army Unmanned Aircraft System Operations***, and Field Manual (FM) 3-20.98 have chapters on platoon elements using UAS to conduct operations. The manuals describe how UAS can be assigned to reconnaissance platoons to conduct detailed recon of danger areas, assist with route recons or be used for contact-by-fire.[6] Concerning UAS elements being controlled by the scout platoon, the manual states, "[T]his relationship allows the platoon the most flexibility. The platoon leader can integrate the capabilities of the UAS into the reconnaissance plan in a seamless manner. He [or she] can then respond quickly to mission/target changes."[7]

Unfortunately in many cavalry troops, the use of UAS, specifically the Raven, isn't seen as a primary sensor system critical to conducting key reconnaissance tasks. This treatment of UAS elements as an ancillary system means that integration of their employment into troop operations is not only ineffectual but often non-existent.[8] Units often don't conduct battle drills with their Ravens, meaning that the crews don't get practice putting their drones into operation quickly during regular operations.[9] For most crews, the only time they bring their Ravens out of the box is either for an inventory or for their 150-day flight for recertification.[10]

More problems such as trying to clear restricted operating zones and commanders worrying about losing systems that were designed to be "thrown away" if lost often means that systems simply sit on supply-room shelves.[11] This lack of use means platoons don't get to practice integrating the troop UAS into their reconnaissance plans.

There are also challenges for the units that do use their UAS systems. With only one Raven team per troop-sized unit, the asset is often prioritized for use against named areas of interest or even farther forward of the platoons to look for possible threats. While it is extremely important to get this this type of intelligence, it often means that unless a platoon is part of the main effort, it cannot use UAS assets in support of its mission. Even with the Raven team under operational control (OPCON) of a platoon, the platoon's leader runs into the same problem of prioritization if operating in two- or three-truck sections.

For example, if all three platoons are running two sections, the troop commander has to divide the use of one UAS element among (potentially) six maneuver elements. This doesn't even include the possibility of dismounted teams. To change this lack of UAS integration, each platoon needs to have two UAS systems organic to its modified table of organization and equipment (MTOE). By having two systems available, the platoon leader can

either have each section use one to aid in its reconnaissance tasks, or use one for close-in ISR support while the second moves in advance of the platoon. In either case, the platoon can use the drones in conjunction with other assets, such as the Long-Range Advanced Scout Surveillance System (LRAS3), to create redundancy in its operations.[12]

For example, picture a scenario where the scout platoon is tasked with route reconnaissance and has two UASs as part of its organic composition. The platoon leader designates Drone A to operate one to two kilometers forward of the maneuvering sections, while Drone B operates directly in front of and to the sides to help clear dead space and laterals. Drone A detects a manmade obstacle and begins overwatch. The platoon leader can maneuver either a truck with an LRAS3 or dismounts with Lightweight Laser Designator Rangefinders onto the site. Now, he or she can detach Drone A to continue searching forward of the platoon or have it stay on station for redundancy of sensors, while Drone B is free to conduct other tasks.

If the platoon leader is instructed to bypass and hand over overwatch to a follow-on element, he or she can have a drone maintain recon while the mounted and/or dismounted elements collapse from their positions. Once done, the elements can move out with one drone still scanning forward as the platoon moves and the other drone watching the area until the handover is complete. Then it can be retasked.

The preceding scenario illustrates why independent operation of two UAS drones at platoon level is beneficial. By having these as readily available assets, platoons can involve them during planned training exercises or during "sergeant's time" in the field. This will increase leadership's understanding of their function, and it will give the operators increased confidence in the equipment and their abilities.

Yet, while the Raven is an important tool in the ISR arsenal, it is not the best UAS asset for the platoon. Instead, a UAS quadcopter design would be most beneficial.

Why quadcopters?

A quadcopter is a UAS drone that uses four motors to power two pairs of counter-rotating, fixed-pitch blades located at its four corners.[13] The motors do not require complex mechanical control linkages to operate because variations in motor speed allow it to maneuver. This simplifies aircraft design and operation.[14] Research has shown that the "most versatile and mechanically easy to construct autonomous aerial vehicle is a quadrotor helicopter."[15] This ease of construction and use is why they have been become highly popular in commercial markets. A simple search on a retail store's Website showed more than 30 different types of quadcopters available with prices ranging from $30 to $3,000.[16]

The most obvious advantage of the quadcopter design is its increased agility over conventional planes. Quadcopters are so agile that the Drone Racing League flies quadcopters over the seats and through the concourses of the Miami Dolphins stadium at speeds approaching 80 mph.[17] This agility means that a quadcopter UAS could fly in environments where a Raven could not, such as within heavily forested areas or vertically dense cities. Where a Raven can only fly over the woods to look for enemy locations, hoping to see them through the foliage, a quadcopter can fly under the canopy to find hostile positions. They can also be flown inside buildings and compounds to help quickly see if there are potential booby traps or ambush sites before execution of a breach.

The quadcopter's ability to hover just feet off the ground while providing real-time imagery day or night would be invaluable to reconnaissance platoons. During route reconnaissance in Afghanistan, scout-platoon dismounts have to clear culverts for the presence of improvised explosive devices before trucks can move forward. While LRAS3s or Ravens can search the area, they can't look low enough to actually see inside the culverts. Therefore dismounts must still try to safely get eyes on. However, a quadcopter that can hover just outside the culvert's opening can get the same intelligence without having to involve a dismount. This keeps Soldiers safe. This same capability can be used to inspect other structures such as bridges, too.

This kind of use of quadcopters is already employed in the civilian sector.[18] The hover and low-level flight ability of these drones also means operators can train themselves and others on basic operations inside large open spaces such as drill floors.

Advantages over Raven

A quadcopter has many advantages over the Raven because of its vertical take-off and landing capabilities, especially when it comes to launch and recovery. The difficulty of launching the Raven in zero wind conditions is increased and requires the crew to throw the system from atop a vehicle or building.[19] The system also requires a clear area to launch safely. Landing must also be made in a clear area, and the system "lands" by stalling about 10 feet off the ground before falling and breaking apart (designed to come apart with easy reassembly).

Instead, a quadcopter can take off easily in calm or windy conditions, and it can pierce the densest forest canopy as long as there is a small hole. A quadcopter drone can not only take off from the operator's hand, but it can land by hovering just a few feet away, allowing the operator to grab it safely from the air. This means that a Bradley crew could launch and recover its UAS just by cracking the top hatch enough to set the quadcopter outside the Bradley.

Regarding the ISR mission, quadcopters have an advantage as well. Both traditional and quadcopter systems have day and night camera operations, but systems like the Raven must continuously circle the target. A quadcopter can instead hover just behind cover and rotate in place to change its view. Many systems come naturally equipped or can have payloads of gimbaled cameras attached to the drone to increase its surveillance ability. The InstantEye family of quadcopters not only can have gimbaled cameras attached, but they can also mount white or infrared floodlights to illuminate targets. They can also mount a 10x zoom video camera.[20]

This ability to attach mission-specific payloads and the increased agility of these platforms are a few of the reasons why the Navy and Marine Corps Small Tactical Unmanned Aircraft Systems Office (PMA-263) ordered 800 InstantEye systems in February 2018.[21] The purpose of the 800 systems is to include them organically into infantry squads to enable ready-to-use UAS capabilities at squad level.[22] The system ordered is the Mk-2 GEN3-A0, which is considered "expendable" since it does not store digital data onboard.[23] It requires only a single operator; can go from stowed to operational in 30 seconds; has a two-kilometers range; and weighs only 1.2 pounds.[24] This same system was also tested by the troopers of 3rd Squadron, 71st Cavalry Regiment, overseas during their deployment for Operation Inherent Resolve.[25]

Figure 1. SPC Michael Kobart (left) and SGT David Vidrine, both with Troop A, 3rd Squadron, 71st Cavalry Regiment, 1st Brigade Combat Team, 10th Mountain Division (Light), inspect the Gen4 InstantEye during training in Baghdad, Iraq. The InstantEye gives Soldiers the ability to see what is around them without endangering personnel. *(U.S. Army photo by SGT Cheryl Cox)*

While there are significant benefits to the quadcopter design, there are disadvantages. The Raven battery gives it a flight time between 60 to 90 minutes on a single charge.[26] Currently systems like the InstantEye Mk-2 GEN3-A0 only have enough battery capacity for about 30 minutes.[27] While industry leaders are currently looking at hybrid power or fuel cells to solve this issue, it may be awhile before they match comparable flight times to traditional UAS like the Raven.[28]

Probably a more significant issue is that of electronic warfare and/or cyber threats. In 2009, newspapers across the country had headlines describing insurgents grabbing Predator drone feeds, using $26 software to access unsecured communications links.[29] Later in 2011, the drone fleet was affected by a virus found on classified and unclassified computers at Creech Air Force Base, NV.[30] An increased awareness of these threats led to the Department of the Army ordering Soldiers to cease all use of the Dajiang Innovation family of quadcopter drones in May 2017, citing "increased awareness of cyber vulnerabilities" as the reason.[31]

Many drones immediately return to a designated point if they lose their control signal.[32] This means that enemy actors could use specialized jammers to create an operational area where our drones cannot operate, not dissimilar to the U.S. military's use of phone jammers overseas. This kind of ability is already being seen in operational theaters. On April 10, 2018, the ***New York Post*** reported that Russia was jamming the Global Positioning System (GPS) components of U.S. drones in Syria.[33] Another similar problem is that drone operations rely heavily on GPS data to know where the ground-control station, the enemy and the UAS are located. Enemy actors could "spoof" the GPS information being received, resulting in the system going to either false-target locations or areas where the enemy could capture the asset.[34] A possible answer would be the use of the already available simple-key loader devices to encrypt drone GPS systems.[35]

Regardless, as technology advances, both the Department of Defense and manufacturers will need to ensure that their drones can face these threats to operate on future battlefields.

How to implement

The Army should designate a mix of Active Component and National Guard squadrons as testing units. These should be a mix of light (such as airborne), medium (Stryker and infantry brigade combat teams) and heavy (armored-cavalry regiments and armored brigade combat teams) squadrons to encompass all aspects of cavalry operations. These units should have two or three trained Soldiers per platoon who receive necessary training in flight and systems management, overseen by a squadron master trainer.

The master trainer would be responsible for both the quadcopters and assets like the Raven. Each platoon would receive two quadcopter UAS systems and start receiving training from the troop trainers. For the MTOE, the drones should be assigned to the section leaders' crews. This would ensure that in either the two- or three-truck section, the UAS would be in the maneuver elements to maximize reconnaissance assets forward.[36]

The troop could then plan force-on-force reconnaissance missions, using both platoons to maintain its UAS proficiency and to start learning how to avoid UAS. With the rise of enemies such as ISIS now using UAS against us, it is imperative that reconnaissance platoons understand how best to counter these operational threats.

The troop should also integrate drone reconnaissance into these missions, using the Raven system to support one of the platoons with its task, or to act as a third party and try to find any opposing-force (OPFOR) maneuvering elements within its designated reconnaissance area. This would give troop and platoon commanders the experience of using the troop's Raven asset to aid in reconnaissance plans. Proficiency should reach a level where the troop can plan a reconnaissance mission with the UAS available, which is habitually integrated in the plan to ensure redundancy and continuous reconnaissance.

While this process is occurring, squadrons would be taking lessons-learned from across the various line units to create a unit standard operating procedure (SOP) for employment of the Raven and quadcopters UAS. The squadron should also start practicing integration of the brigade's organic UAS asset: the RQ-7 Shadow aerial-reconnaissance platoon.[37]

The increase of UAS assets in the area of operations will require deconflicting airspace with conventional fixed- and rotary-wing aircraft. This will be a key task for the squadron tactical-operations center.

The Marines experienced this issue during the Sea Dragon 2025 Integrated Training Exercise. Solutions they found were the use of brevity codes to automatically bring UAS down to either a restricted altitude and/or grounding flights if low-level close-air-support was needed, and developing a five-line radio call (to provide pertinent information for air assets) to submit to higher to get company-level UAS to fly higher than 1,000 feet above ground level.[38]

The culminating event for the squadron would be to go to a training center to conduct a force-on-force operation with UAS integration from squadron to platoon level. This could either be done as part of a brigade rotation or as a stand-alone event. During this event, a Shadow aerial-reconnaissance platoon should be OPCON to the squadron. Once all the squadrons finish their rotations, an evaluation of lessons-learned from both the squadrons and the OPFOR should be conducted. The Army could then take this information and create a cavalry-squadron UAS SOP and best practices for all cavalry units to use going forward.

The final key to the implementation process is getting leadership the resources to best access the incoming UAS feeds. Currently, most troop and platoon leaders do not have the capability to watch drone feeds from any UAS asset inside their vehicles while moving. A possible solution could be the installation of viewing systems such as the One-System Remote Video Terminal (OSRVT) into vehicles. This laptop-like system has an adaptor kit, so it can operate from almost every Army vehicle.[39]

In 2015, a Stryker brigade used the OSRVT system, installing it from brigade to company level during a rotation at the National Training Center, Fort Irwin, CA.[40] If these systems are able to view feeds from quadcopter UAS, then installing them into the vehicles of the section leader, platoon sergeant and platoon leader would enable the leaders to view footage from UAS systems organic at all levels of a brigade. These systems should also be installed in the vehicles of the troop commander, first sergeant, executive officer and the TOC to enable the same capability. Even if the platoons do not get their own UAS, the troop and platoon leadership should still be equipped with drone-viewing systems to better integrate the UAS assets they already have.

Other alternatives could include using radio systems such as the Harris Corps' RF-335, which is designed to support full-motion video from nearby drones, a capability that could even be used by dismount team leaders away from vehicle-based systems.[41]

Conclusion

While the "standard-issue cavalry scout" will always be the Army's primary reconnaissance sensor, that scout will need other systems to help increase effectiveness, namely drones. The use of drones on the battlefield will grow exponentially during the next 10 years as technology advances. As an indicator of this, U.S. Special Operations Command requested more than $74 million for the 2019 fiscal year (FY) to procure a variety of UAS, including $10 million for 527 nano-sized vertical take-off and landing UASs.[42]

The Army's "cargo-pocket" ISR program is already looking at deploying pocket-sized aerial-surveillance devices to the squad level.[43] In the future, these will be essential to small-team operations such as a dismounted listening posts/observation posts, but at the platoon level, it will still be essential to have an organic UAS asset that can provide real-time intelligence on the move. As stated in the ***Reconnaissance and Scout Platoon*** manual, "UASs provide additional information needed by the platoon leader to determine which routes and cross-country terrain best accommodate reconnaissance operations."[44]

While there are currently multiple UAS already available, none of these can match the agility and employability of the quadcopter UAS. They are more agile, simple to deploy and can operate even in dense vegetation and complicated urban terrain. Quadcopters also have the capability to land on terrain or buildings, and they can be used as a remote video sensor, something no Raven could even attempt. Simply put, the addition of quadcopter UAS into the platoons would only increase their ISR capabilities and overall lethality.

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Notes

[1] FM 3-20.98, ***Reconnaissance and Scout Platoon***, Headquarters, Department of the Army, 2009.
[2] CPT Christopher M. Brandt, "The Future of Unmanned Systems in Cavalry Squadrons," ***ARMOR***, April-June 2015 edition.
[3] Alan Kim, Brandon Wampler, James Goppert and Inseok Hwang, "Cyber Attack Vulnerabilities Analysis for Unmanned Aerial Vehicles," American Institute of Aeronautics and Astronautics, 2012.
[4] Mark Pomerieau, "How $650 drones are creating problems in Iraq and Syria," ***C4ISRNET***, Jan. 5, 2018, https://www.c4isrnet.com/unmanned/uas/2018/01/05/how-650-drones-are-creating-problems-in-iraq-and-syria/.
[5] Ibid.
[6] FM 3-20.98.
[7] Ibid.
[8] CPT John Albert, "A Practical Guide for Excellence in Company Unmanned Aircraft System Operations," ***ARMOR***, July-September 2016.
[9] Ibid.
[10] SGT Joshua Laidacker, "Vanguards recertify with Raven UAS," Army News Service, accessed May 29, 2018, https://www.army.mil/article/122541/vanguards_recertify_with_raven_uas.
[11] David Hickman, "UAS Implementation at the Platoon Level," ***sUAS News***, Nov. 7, 2011, https://www.suasnews.com/2011/11/uas-implementation-at-the-platoon-level/.
[12] FM 3-20.98.
[13] D.C. Patel, G.S. Gabhawala, A.K. Kapadia, N.H. Desai and S.M. Sheth, "Design of Quadcopter in Reconnaissance," paper presented for International Conference on Innovations in Automation and Mechatronics Engineering 2013, Feb. 21-23, 2013, https://www.researchgate.net/publication/271835155_Design_of_Quadcopter_in_Reconnaissance.
[14] Ibid.
[15] Ibid.
[16] Walmart, drones with cameras and video cameras search, accessed June 2, 2018, https://www.walmart.com/search/?cat_id=3944_133277_1231385&grid=true&query=drones+with+camera+ands+video+camera&typeahead=drones#searchProductResult.
[17] "Drone Racing at the Miami Dolphins Stadium," ***Wired*** (UK), May 20, 2016, https://www.youtube.com/watch?v=ixFayeB1NIY.
[18] Patel et al.
[19] FM 3-20.98.
[20] InstantEye Robotics, "InstantEye Mk-2 Payloads," accessed June 2, 2018, https://instanteyerobotics.com/products/payloads/.
[21] Kimberly Kohlheep, "United States Marine Corps Orders 800 InstantEye Systems," ***InstantEye Robotics***, Feb. 6, 2018, https://instanteyerobotics.com/uncategorized/united-states-marine-corps-orders-800-instanteye-systems/.
[22] Connie Lee, "Marine Corps Begins Delivering Quadcopters to Squads," ***National Defense Magazine***, Feb. 6, 2018, http://www.nationaldefensemagazine.org/articles/2018/2/6/marines-corps-begins-delivering-quadcopters-to-squads.
[23] InstantEye Robotics, "InstantEye Mk-2 GEN3-A0 sUAS Spec Sheet," accessed June 2, 2018, https://instanteyerobotics.com/wp-content/uploads/2017/11/InstantEye-Mk-2-GEN3-A0-v2.3-11-20-17.pdf.
[24] Ibid.
[25] SGT Cheryl Cox, "InstantEye brings security, situational awareness to 10th Mountain Soldiers," Army News Service, March 3, 2016, https://www.army.mil/article/163463/instanteye_brings_security_situational_awareness_to_10th_mountain_soldiers.
[26] FM 3-20.98.
[27] InstantEye Mk-2 GEN3-A0 sUAS spec sheet.
[28] Brandt.
[29] Siobhan Gorman, Yochi Dreazan and August Cole, "Insurgents Hack U.S. Drones," ***Wall Street Journal***, Dec. 17, 2009, https://www.wsj.com/articles/SB126102247889095011.
[30] Noah Shachtman, "Exclusive: Computer Virus Hits U.S. Drone Fleet," ***Wired***, Oct. 7, 2011, https://www.wired.com/2011/10/virus-hits-drone-fleet/.
[31] LTG Joseph Anderson, "Discontinue Use of Daijang Innovation (DJI) Corporation Unmanned Aircraft Systems [Memorandum for Record]," retrieved from https://d3ciwvs59ifrt8.cloudfront.net/17ccfa30-82ea-4870-b441-3e19d1395c29/c075d4f1-ffde-4a76-b415-c5d611debe47.pdf.
[32] Brandt.
[33] Yaron Steinbuch, "Russia reportedly jamming US drones in Syria," ***New York Post***, April 10, 2018, https://nypost.com/2018/04/10/russia-reportedly-jamming-us-drones-in-syria/.

[34] Kim, et al.
[35] Natick Contracting Division, Army Contracting Command, "Short Range Micro (SRM) Unmanned Air Vehicle Salient Characteristics: Short-Range SUAS System Requirements," accessed June 4, 2018, http://www3.natick.army.mil/docs/SUAS/Attachment6_Short_Salient.pdf.
[36] Headquarters Department of the Army, FMI 3-04.155, ***Army Unmanned Aircraft System Operations***, 2006.
[37] Ibid.
[38] Noncommissioned officers and officers, 3rd Battalion, 5th Marines, "Sea Dragon 2025: Small Unit Leaders' Thoughts," ***Marine Corps Gazette***, Vol. 101, Issue 4, https://www.mca-marines.org/gazette/2017/03/sea-dragon-2025-small-unit-leaders-thoughts.
[39] Kris Osborn, "Soldiers See Real-Time Drone Feeds From Handheld Devices," ***Warrior Maven***, March 4, 2018, https://defensemaven.io/warriormaven/land/soldiers-see-real-time-drone-feeds-from-new-handheld-devices-o-JrqY1MikmR_5v5D_AcvA/.
[40] Defense Department, FY15 Army programs, OSRVT Increment II, 2015.
[41] Osborn.
[42] Vivienne Machi, "SOCOM Setting Records for Unmanned Systems Procurement," ***National Defense Magazine***, May 14, 2018, http://www.nationaldefensemagazine.org/articles/2018/5/14/socom-setting-records-for-unmanned-systems-procurement.
[43] Jeffrey Sisto, "Army researchers develop Cargo Pocket ISR," Army News Service, July 21, 2014, https://www.army.mil/article/130189/army_researchers_develop_cargo_pocket_isr.
[44] FM 3-20.98.

Acronym Quick-Scan

FM – field manual
FMI – field manual interim
FY – fiscal year
GPS – Global Positioning System
ISIS – Islamic State in Iraq and Syria
ISR – intelligence, surveillance and reconnaissance
LRAS3 – Long-Range Advanced Scout Surveillance System
MTOE – modified table of organization and equipment
OPCON – operational control
OPFOR – opposing force
OSRVT – One-System Remote Video Terminal
SOP – standard operating procedure
UAS – unmanned aerial system