Staff Sgt. Stetson Manuel, a robotics and autonomous systems platoon sergeant from Alpha Company, 1st Battalion, 29th Infantry Regiment, 316th Cavalry Brigade, carries the Ghost-X Unmanned Aircraft System after its Project Convergence–Capstone 4 experimentation flight on 11 March 2024 at Fort Irwin, California. (Photo by Sgt. Charlie Duke, U.S. Army)

Unmanned Aircraft and the Revolution in Operational Warfare

Preparing the U.S. Army for the Age of Unmanned Systems

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According to Eliot Cohen's framework for understanding revolutions in military affairs, the widespread employment of unmanned aircraft systems (UAS) in the Russo-Ukrainian War represents a fundamental transformation in the conduct of operational warfare, as it demonstrates the confluence of new weapons, new organizations, and new ways of war (see the table).[1] This transformation manifests in fundamental changes to how forces plan and execute campaigns, integrate intelligence within operations, and approach command and control, with particularly significant implications at the operational level of war.[2]

As division and corps commanders must now account for persistent surveillance capabilities that eliminate traditional advantages of operational surprise while simultaneously leveraging new capabilities for deep strike and operational shaping, the experience of Ukrainian and Russian forces provides valuable lessons for how operational commanders must adapt to this new reality.[3] The widespread adoption of UASs has fundamentally altered the operational environment, creating conditions of near-persistent surveillance that challenge traditional concepts of military operations.[4]

Drawing on emerging evidence to demonstrate how these systems represent new weapons, organizations, and ways of war, this article examines the transformative impact of UASs on operational warfare through the lens of the Russo-Ukrainian War. It then explores the implications of this revolution for the U.S. Army at the operational level, offering specific recommendations for how the service must adapt its doctrine, organization, and leader development to succeed in future conflicts.

UASs as New Weapons: Transforming Operational Capabilities

The evolution of UAS employment. Demonstrating how UASs have transformed operational warfare, the Battle of Avdiivka in early 2024 saw Ukrainian corps-level commanders employing UASs weekly across the operational area, not merely as tactical assets but as integrated elements of operational design.[5] These systems enabled persistent surveillance across the entire operational depth, fundamentally changing how forces plan and execute operations. More significantly, the integration of UASs with operational fires created new possibilities for deep strike and operational shaping, allowing commanders to affect the battlefield simultaneously across multiple domains and distances.[6]

Beyond traditional military applications, the operational impact extends further as Ukrainian forces have demonstrated remarkable innovation in adapting commercial UAS technology for military purposes. According to Stacie Pettyjohn, senior fellow and director of the defense program at the Center for a New American Security, Ukrainian forces routinely employ commercial drones modified with thermal imaging capabilities for night operations, enabling sustained twenty-four-hour surveillance and strike capabilities.[7] At the operational level, this adaptation has particular significance, as the ability to maintain continuous observation has transformed how commanders understand and shape the battlefield.[8]

Deep strike and operational shaping. Illustrating how UASs enable new approaches to operational shaping, Ukraine's April 2024 Belgorod raids saw Ukrainian forces employing over two hundred UASs in coordinated operations, demonstrating how unmanned systems allow operational commanders to create and exploit opportunities at unprecedented scale.[9] These operations integrated reconnaissance, electronic warfare, and strike missions in ways that fundamentally altered the relationship between operational planning and execution. The raids forced Russian operational commanders to commit significant resources to rear area defense, demonstrating how UASs enable smaller forces to achieve operational effects previously requiring much larger formations.[10]

Ukrainian forces have developed innovative ways of employing UASs for tactical strikes and battlefield shaping operations, particularly through the integration of first-person-view drones and loitering

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Table. Cohen's RMA Criteria Applied to UASs in the Russo-Ukrainian War

RMA Criterion	Evidence from the Russo-Ukrainian War
New Weapon	• Unprecedented proliferation and diversity of unmanned aircraft system (UAS) types • Rapid technological advancements (e.g., Bober heavy first-person-view bomber, Shahed-136) • Integration of AI and machine learning • Accessibility and cost-effectiveness ("Poor Man's Airforce") • Democratization of air power capabilities
New Organization	• Creation of Ukraine's Unmanned Systems Forces • Novel recruitment and training methods for UAS operators • Formation of specialized UAS teams (pilots, explosive ordnance disposal specialists, maintainers) • Integration of civilian education for drone operations • Russian proposals for "unmanned-centric" brigade concepts
New Way of War	• Expansion of battlefield vertically and horizontally • New tactics (e.g., UAS swarms, drone stacks) • Integration with conventional weapons systems • Changes in decision-making and command structures • Psychological impact on troops and public perception • Shift in economic calculus of warfare • Development of new counter-UAS strategies

(Table by author)

munitions. While these systems may not have the range typically associated with deep strike capabilities, they have proven highly effective against high-value targets within their operational reach. Ukrainian commanders have leveraged the relatively low cost and high accuracy of these systems to develop new tactical concepts, such as using first-person-view drones for real-time reconnaissance and target acquisition and employing loitering munitions for precision strikes against enemy armor, artillery, and command posts.[11]

The ability to conduct persistent, high-precision strikes at the tactical level has fundamentally changed how Ukrainian commanders approach battlefield preparation and exploitation. By using these systems to systematically degrade Russian combat power and disrupt their operations, Ukrainian forces have been able to create opportunities for decisive maneuver and counterattacks.[12] This tactical innovation has had operational-level impacts, enabling Ukrainian forces to seize the initiative during various phases of the war and shape the battlefield in their favor. However, it is important to note that these shorter-range systems are not a substitute for genuine deep strike capabilities such as long-range UASs like the Shahed or various other systems, which can conduct strikes far behind enemy lines. Rather, they represent a complementary capability that enhances the overall effectiveness of Ukrainian operations at the tactical and operational levels.

Integration with Conventional Forces

Ukrainian commanders have developed sophisticated approaches to employing UASs in support of ground maneuver while simultaneously conducting independent deep operations, creating new operational synergy between UASs and conventional forces.[13] Extending beyond simple support relationships, this integration represents new ways of thinking about operational effects. By maintaining persistent surveillance while simultaneously conducting precision strikes, Ukrainian commanders have fundamentally altered how they approach battlefield preparation and exploitation.[14]

During the Battle of Kherson in late 2022, for example, Ukrainian forces employed swarms of small drones to identify Russian defensive positions and guide long-range fires, allowing them to rapidly degrade enemy combat power before launching a ground offensive.[15] This UAS-enabled targeting allowed Ukrainian

commanders to shape the battlefield at a tempo and scale previously impossible, setting conditions for a successful counterattack that liberated the city.[16]

David Hambling notes that the integration of UASs with artillery has been particularly transformative, as drones have made Ukrainian artillery "lethally accurate," allowing real-time adjustments of fire and immediate battle damage assessment.[17] This capability has changed the calculus of fire support, enabling commanders to employ artillery with unprecedented precision and responsiveness. Pairing drones with artillery has also allowed Ukrainian forces to engage targets across the operational depth, striking key Russian command posts, logistics hubs, and lines of communication.[18]

New Organizational Structures for Operational Success

Ukraine's Unmanned Systems Forces. Representing the most comprehensive organizational response to this operational revolution, Ukraine's establishment of the Unmanned Systems Forces (USF) in 2024 emphasizes operational-level integration and effects, unlike traditional military branches focused on tactical employment.[19] The structure maintains dedicated operational-level formations capable of supporting corps and division operations while simultaneously conducting independent deep operations. This organizational innovation demonstrates how unmanned systems require new concepts for force structure and command relationships at the operational level.[20] Aiming to support operations with "over a million indigenously developed first-person view unmanned aircraft systems," this new branch demonstrates Ukraine's commitment to reshaping its military structure around unmanned systems through massive investment in UAS technology and organization.[21] The appointment of Col. Vadym Sukharevskyi, described as "one of the first commanders in Ukraine to effectively deploy unmanned aerial vehicles (UAVs) in combat," as the first commander of the USF, underscores the emphasis on practical experience and expertise in unmanned operations at the highest levels of command.[22]

By creating a dedicated branch for unmanned systems, Ukraine's USF represents a fundamental shift in how militaries organize for operational success. This allows for the rapid development and dissemination of new tactics, techniques, and procedures, fostering a culture of innovation and adaptation by institutionalizing the importance of these capabilities and ensuring their integration into all aspects of operational planning and execution.[23] Providing a model for how militaries can leverage tactical successes into operational advantages, the USF enables the rapid scaling of successful tactics and technologies across the entire force by consolidating expertise and resources at the operational level.[24] This ability to quickly translate tactical innovations into operational capabilities has been a key factor in Ukraine's ability to resist Russian aggression.

Transformation of operational headquarters. To integrate unmanned systems across all warfighting functions, Ukrainian corps and division staffs have evolved by adapting their processes to account for persistent surveillance capabilities and new strike options.[25] While intelligence sections developed new approaches to processing and analyzing the vast amounts of information available from UAS operations, operations sections created new planning processes that fully leverage unmanned capabilities.[26] For example, Ukrainian operational headquarters have established dedicated UAS cells responsible for integrating drone operations into overall campaign planning.[27] Working closely with intelligence and operations sections to ensure that UAS capabilities are fully leveraged in support of operational objectives, these cells also serve as conduits for rapidly disseminating new tactics and technologies across the force, ensuring that lessons learned are quickly applied at scale.[28] Ukrainian staffs have also developed new processes for managing the massive amounts of data generated by UAS operations, including the use of artificial intelligence and machine learning algorithms to process imagery, identify targets, and prioritize intelligence collection.[29] These technological innovations have allowed Ukrainian commanders to make sense of the operational environment and make decisions at a pace previously impossible.

Adopting a markedly different organizational approach at the operational level, Russian forces attempted to integrate UAS capabilities into existing headquarters structures while maintaining specialized drone units at higher echelons. This approach proved less effective, particularly in coordinating deep operations and managing the flow of intelligence.[30] The

The Textron Systems' MK 4.8 HQ Aerosonde unmanned aircraft system flies during testing at Redstone Arsenal, Alabama, on 20 December 2024. The MK 4.8 HQ Aerosonde was introduced into Army service in late 2024. (Photo by David Hylton, Program Executive Officer, Aviation)

contrast between Ukrainian and Russian approaches demonstrates the importance of organizational adaptation in leveraging new capabilities.[31] Highlighting the challenges of integrating disruptive technologies into existing organizational structures, the Russian experience underscores the importance of organizational change in adapting to revolutionary military technologies, as by attempting to fit UASs into legacy command-and-control systems, Russian forces limited their ability to fully leverage these capabilities at the operational level.[32]

A new way of operational warfare. Perhaps the most significant aspect of this revolution, the transformation of operational art through UAS integration represents a new understanding of how to conduct large-scale operations in the age of unmanned systems. Traditional concepts of operational maneuver based on massing forces at decisive points while achieving surprise require fundamental revision in an environment of persistent surveillance.[33] Developing new approaches emphasizing distributed operations, deception, and the ability to mass effects rather than forces, Ukrainian operational commanders extend these changes beyond tactical adaptation.[34]

Transformation of operational decision-making. The operational decision cycle has undergone particular transformation in the age of unmanned systems. Division and corps commanders now operate in an environment where the time between detection and engagement has compressed dramatically, while they must simultaneously manage vast amounts of real-time intelligence.[35] Ukrainian forces developed new decision-making processes that push significant authority to lower echelons while maintaining operational coherence through mission command. This approach enables rapid exploitation of opportunities while ensuring subordinate units understand and operate within the commander's intent.[36]

Reshaping operational decision-making processes, the integration of artificial intelligence and machine learning with UASs is pointing toward a future where unmanned systems may operate with increasing autonomy, as Ukraine's efforts to develop drones with onboard AI for target recognition demonstrate.[37] While

raising important questions about human oversight and control, this development has significant implications for operational command and control, potentially allowing for faster decision cycles.[38] For example, Ukrainian commanders have experimented with AI-enabled UASs capable of independently identifying and engaging targets based on preset parameters.[39] While human operators remain in the loop for weapon release authority, these systems represent a significant step toward autonomous operations. The use of such systems has the potential to dramatically accelerate the pace of operations, allowing commanders to exploit fleeting opportunities and rapidly respond to changing battlefield conditions.

However, the increasing autonomy of unmanned systems also presents significant challenges for operational command and control. As these systems become more capable of independent action, commanders must develop new ways of ensuring human control and accountability.[40] This requires the development of robust command-and-control architectures, clear rules of engagement, and operator training.[41]

Evolution of operational reach. Through UAS employment, the concept of operational reach has evolved significantly, as Ukrainian forces demonstrated the ability to conduct deep strikes and shaping operations at distances previously requiring significant conventional force commitments.[42] More importantly, these operations demonstrated new approaches to operational synchronization, with unmanned systems enabling commanders to simultaneously affect multiple points across the battlefield. This capability requires new ways of operational design that account for both the opportunities and vulnerabilities created by unmanned systems.[43] Demonstrating how UASs have expanded operational reach, the April 2024 strike on targets in Russia's Tatarstan region, more than 1,300 kilometers from Ukraine's border, represents a significant shift in operational possibilities, allowing commanders to shape the battlefield at unprecedented depths with relatively limited resources.[44]

The expansion of operational reach through UASs has significant implications for the geographic scope of conflicts. As unmanned systems enable strikes at ever-increasing ranges, the distinction between frontline and rear areas becomes increasingly blurred.[45] This development challenges traditional notions of battlefield geometry and requires commanders to think more expansively about the operational environment. Moreover, the ability to conduct long-range strikes with UASs has the potential to escalate conflicts in unintended ways. As the boundaries of the battlefield expand, the risk of drawing in additional actors or provoking retaliation increases.[46] Commanders must carefully consider the strategic implications of UAS operations and ensure that they are fully integrated into overall campaign plans.

Implications for U.S. Army Operational Art

Doctrinal evolution. The transformation of operational warfare through unmanned systems demands fundamental changes in how the U.S. Army approaches operational art. Operational doctrine must evolve to account for new realities of persistent surveillance and precision strike capabilities.[47] Traditional concepts of operational security and surprise require revision when enemy forces can maintain constant observation across the operational depth. Updated doctrine must emphasize deception, electronic warfare, and the ability to operate effectively despite enemy surveillance.[48]

While acknowledging the importance of unmanned systems, the Army's current modernization strategy requires significant expansion to address the operational implications of this revolution.[49] Representing an important step, the Department of Defense's Replicator initiative, aimed at rapidly scaling autonomous capabilities, must be integrated into a broader transformation of operational doctrine and concepts.[50] For example, the Army must develop new doctrinal concepts for employing UASs in support of deep operations, to include intelligence collection, targeting, and strike missions. These concepts must address the unique challenges of operating unmanned systems at extended ranges and in contested environments, such as communications reliability, navigational accuracy, and survivability.[51]

Army doctrine must also evolve to account for the increasing use of AI and autonomous systems in operational warfare. This requires the development of clear ethical and legal frameworks for the employment of these systems and comprehensive operator training and certification standards.[52] Doctrine must also address the challenges of human-machine teaming at the operational

level, to include command-and-control arrangements, data management, and decision support systems.[53]

Leader development and education. Future corps and division commanders and staffs must understand both the opportunities and limitations of unmanned systems while developing new approaches to operational decision-making. The Ukrainian experience demonstrates that successful operational commanders in unmanned-intensive environments require a sophisticated understanding of technical capabilities while maintaining focus on operational art, making leader development a particular area of attention.[54]

Professional military education must evolve to prepare leaders for this new operational environment. The Army should revise curricula at intermediate and senior service colleges to emphasize updates to operational art that account for persistent surveillance and precision strike capabilities.[55] This education must go beyond technical understanding to develop leaders capable of integrating unmanned capabilities into sophisticated campaign designs. For example, the Army educational institutions should incorporate modules on unmanned systems into its core curriculum, with a particular emphasis on their operational implications. These modules should include case studies of UAS employment in recent conflicts, war games and simulations that replicate unmanned-intensive environments, and opportunities for students to develop and test new operational concepts.[56]

Leader development programs should place greater emphasis on cultivating the cognitive skills required to operate effectively in complex, data-rich environments, including training in critical thinking, adaptability, and rapid decision-making under conditions of uncertainty.[57] Leaders must also be comfortable with delegating authority to subordinates and operating in decentralized command structures.[58]

Organizational adaptation. To leverage unmanned capabilities effectively, the U.S. Army must consider significant organizational changes. While some, such as Lt. Col. Robert Solano, argue for the creation of a separate drone branch, similar to Ukraine's approach, the Army must carefully consider how best to integrate unmanned capabilities across all echelons while maintaining operational effectiveness.[59] As demonstrated in Ukraine, successful integration of unmanned capabilities requires new approaches to staff organization and processes, making the transformation of operational headquarters a particularly urgent requirement.[60] The Army must develop new models for operational headquarters that can effectively process and act upon the vast amounts of information provided by unmanned systems while maintaining the ability to conduct rapid decision-making and execution.[61] For example, the Army should consider establishing dedicated UAS cells within corps and division headquarters, similar to the Ukrainian model. These cells would be responsible for planning and integrating unmanned operations across the operational depth, in close coordination with intelligence, fires, and maneuver elements.[62]

The Army must also invest in the technical infrastructure required to support unmanned operations at scale, including robust communications networks, data management systems, and analytical tools capable of processing the massive amounts of information generated by UAS sensors.[63] Developing new systems that account for cybersecurity and electronic protection to ensure the integrity of unmanned systems in contested environments is also crucial.[64]

Recommendations for U.S. Army Adaptation

Structural changes. To prepare for this transformation in operational warfare, the U.S. Army must undertake several key initiatives. First, the Army should establish operational-level unmanned formations at corps and division levels, following the Ukrainian model of integrated unmanned capabilities.[65] These formations must maintain the ability to conduct both independent deep operations and support to conventional forces while developing new approaches to operational integration.[66]

Providing a framework for rapidly scaling autonomous capabilities, the Department of Defense's Replicator initiative requires the Army to develop specific organizational structures to effectively employ these systems.[67] This should include the creation of dedicated unmanned warfare centers at the operational level, similar to Ukraine's approach, to develop and implement new operational concepts.[68]

The Army should also consider establishing a dedicated Unmanned Systems Command, responsible for developing and overseeing the service's unmanned

Two Ukrainian soldiers from the Unmanned Systems Forces calibrate a Ukrainian "Vampire" unmanned aircraft. The hexacopter can carry fifteen kilograms of ammunition or other cargo. (Photo by Olena Khudiakova, Ukrinform)

capabilities. This command would serve as a focal point for unmanned systems doctrine, training, and materiel development, ensuring a cohesive and integrated approach across the force.[69]

Training and education reform. To prepare soldiers and leaders for the challenges of unmanned warfare, the Army must reform its training and education programs at all levels. This reform should include the development of specialized courses focused on the tactical employment of unmanned systems as well as the integration of unmanned scenarios into existing training exercises.[70] These programs should emphasize hands-on experience with UAS and counter-UAS systems, allowing soldiers to gain familiarity with their capabilities and limitations in realistic operational environments.[71]

Operational exercises should also evolve to include realistic unmanned threats and opportunities, enabling commanders and staffs to gain proficiency in the operational battlefield of the future. The Army should follow Ukraine's lead in developing specialized courses for drone operators and mission planners, establishing dedicated training programs for unmanned operations that emphasize both technical proficiency and operational integration.[72] One example is creating a training program for corps and division staff officers centered on integrating unmanned systems into operational planning and execution. This program should feature classroom instruction on UAS capabilities and limitations, hands-on training with actual systems, and simulated exercises that mimic the complexity of unmanned-intensive environments.[73]

Furthermore, the Army should harness virtual and augmented reality technologies to design immersive training environments that accurately simulate the challenges of unmanned warfare. These environments should provide leaders with opportunities to practice decision-making and command and control in realistic, data-rich scenarios.[74]

Doctrinal development. Accelerating the development of new operational doctrine that reflects the realities of unmanned warfare is imperative for the Army. This doctrine should focus on several key areas, such as integrating unmanned systems into combined arms operations, command and control in unmanned-intensive

environments, counter-UAS operations at the operational level, and employing autonomous systems in deep operations.[75] The development of this doctrine should draw directly from Ukrainian experiences while considering unique U.S. Army requirements and capabilities. Particular attention should be given to the integration of artificial intelligence and autonomous systems, as these areas present both opportunities and risks that must be carefully evaluated.[76]

For instance, the Army should create an operational framework for employing unmanned systems in support of multidomain operations. This framework should outline how UASs can be integrated with space, cyber, and electronic warfare capabilities to generate synergistic effects across the operational depth.[77] Managing the massive amounts of data generated by unmanned operations is another critical aspect that the Army must address in its doctrine. Guidelines for data collection, processing, exploitation, and dissemination should be developed or refined, along with standards for interoperability and data sharing with joint and multinational partners.[78]

Technical integration. Developing new means to manage the vast amounts of data generated by unmanned systems is a key challenge for the Army. This includes creating AI-enabled systems for processing UAS intelligence, building robust and resilient communication networks, integrating unmanned systems with existing command-and-control structures, and implementing counter-UAS capabilities across all echelons.[79] The technical architecture supporting unmanned operations must be sophisticated enough to handle complex operations while remaining simple enough to maintain in combat conditions, which represents a crucial challenge for future force development.[80]

To illustrate, the Army should invest in advanced data analytics and machine-learning capabilities to automate the processing and exploitation of UAS sensor data. These capabilities should be scalable and deployable at the tactical level, allowing commanders to quickly make sense of complex operational environments.[81] Prioritizing the development of secure, jam-resistant communications networks capable of supporting unmanned operations in contested environments is another essential task for the Army. These networks must be able to operate in degraded conditions and ensure the integrity of command-and-control links.[82]

Conclusion

The revolution in operational warfare driven by unmanned systems demands a transformation of U.S. Army capabilities, organization, and doctrine. The evidence from Ukraine demonstrates that successful adaptation requires more than just technological solutions or tactical innovation; it demands fundamental changes in how operational commanders approach campaign design, staff organization, and decision-making. The cost of failing to adapt to these changes could prove catastrophic in future conflicts, as potential adversaries demonstrate increasingly sophisticated operational employment of unmanned systems.

Success in future conflicts will depend on the Army's ability to adapt operational art to the age of unmanned systems while maintaining proficiency in legacy military capabilities, as it stands at a critical juncture in its historical development. This transformation requires a careful balance between leveraging new technologies and maintaining focus on fundamental principles of operational art. It necessitates developing updates appropriate for American military requirements and strategic objectives, while the lessons from Ukraine provide valuable insights.

As Jacquelyn Schneider and Julia Macdonald argue, the key to successful military innovation lies not just in adopting new technologies but in developing new operational concepts that effectively integrate these capabilities into broader military operations.[83] The integration of unmanned systems into operational warfare represents more than just a tactical or technological challenge; it requires a fundamental rethinking of how modern armies fight at the operational level.

The U.S. military's ability to successfully navigate this transformation will play a crucial role in determining its effectiveness in future conflicts. By embracing the lessons of the Russo-Ukrainian War and committing to reform, the Army can position itself to lead the way in this new era of operational warfare. Ultimately, the Army must adapt its doctrine, organization, and training to fully leverage the potential of unmanned systems while mitigating the risks and challenges they present. Only through a holistic approach to innovation can the Army ensure its continued success on the battlefields of the future. ■

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