TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

ACTA TECHNICA NAPOCENSIS

Series: Applied Mathematics, Mechanics, and Engineering
Vol. 69, Issue Special III, July, 2026

SHIFTING PARADIGMS IN CONCEPT, ACTION, AND TRAINING: ADDRESSING THE PROLIFERATION OF UNMANNED AERIAL SYSTEMS IN MODERN WARFARE

Constantin GRIGORAȘ, Ștefan-Cristian PETRE

Abstract: *This article argues that the integration of Unmanned Aerial Systems (UAS) has fundamentally disrupted modern warfare, transitioning drones from strategic enablers to ubiquitous shooters. It traces this evolution through three operational epochs, culminating in Hyper-Warfare, characterized by extreme OODA loop compression and the Transparent Battlefield where concealment is obsolete. However, the text contends that a prevailing hardware-first procurement strategy has created a critical capability gap. While airframes have advanced, operator education remains stagnant, leading to cognitive saturation, vigilance decrement, and psychological burnout. The article proposes a strategic pivot to a Competency-Based Training model, outlining a three-tier educational hierarchy—Manual Proficiency, Systems Management, and Tactical Decision Making—to restore the human element as the decisive advantage in autonomous conflict.*

Keywords: *Unmanned Aerial Systems (UAS), Hyper-Warfare, Transparent Battlefield, OODA Loop, Cognitive Load, Competency-Based Training, Drone Warfare, Human-Machine Teaming.*

1. MILESTONES IN THE EMPLOYMENT OF UAS IN MILITARY OPERATIONS

The integration of Unmanned Aerial Systems (UAS) into the Joint Force has transcended the boundaries of a mere technological update, constituting a genuine Revolution in Military Affairs (RMA). This chapter examines the operational lineage of UAS, arguing that we have witnessed a transition from *UAS as an Enabler* (supporting the sensor-to-shooter loop) to *UAS as the Shooter* (closing the loop autonomously). This evolution is categorized into three operational epochs.

1.1 Epoch I: Strategic Persistence in Permissive Environments (2001–2014)

The post-9/11 era defined the initial doctrinal utility of UAS, characterized by the employment of Medium Altitude Long Endurance (MALE) platforms like the MQ-1 Predator and MQ-9 Reaper in uncontested airspace. During Operations Enduring Freedom (OEF) and Iraqi Freedom (OIF), the primary operational value was the establishment of persistent stare capabilities. United States Air Force data indicates that the demand for UAS Combat Air Patrols (CAPs) surged by over 1,200% between 2004 and 2011, and by 2010, the USAF was logging more operational hours with unmanned aircraft than with manned fighters in the CENTCOM Area of Responsibility [1]. However, despite their undeniable efficacy in High-Value Target (HVT) interdiction, these systems operated under the umbrella of total air supremacy. Consequently, they were effectively non-factors in Anti-Access/Area Denial (A2/AD) environments, serving primarily to shorten the Find, Fix, Finish (F3) cycle within the specific constraints of counterinsurgency (COIN) operations.

1.2 Epoch II: The SEAD/DEAD Disruption and the Second Drone Age (2020)

The 2020 Nagorno-Karabakh conflict marked a definitive turning point, validating the concept that mid-tier powers could achieve localized air superiority through UAS without relying on a fifth-generation manned air force.

This epoch was defined by the TB2 Effect, where Azerbaijan's integration of the Bayraktar TB2 (MALE) with IAI Harop (Loitering Munitions) systematically dismantled Armenia's Soviet-legacy Integrated Air Defense System (IADS). Independent analysis confirmed that Azerbaijani UAS were responsible for the destruction of approximately 106 tanks, 146 artillery pieces, and significantly, sixty-two surface-to-air missile systems, including S-300 and Pantsir-S1 units [2]. This conflict proved the viability of UAS in Suppression of Enemy Air Defenses (SEAD) and Destruction of Enemy Air Defense (DEAD) missions, establishing a heavily asymmetric cost-exchange ratio where a modest UAS package could neutralize high-value IADS batteries.

1.3 Epoch III: Mass, Attrition, and the FPV Phenomenon (2022–Present)

The Russo-Ukrainian War has introduced the current paradigm: high-intensity, large-scale combat operations (LSCO) characterized by the ubiquity of Commercial Off-The-Shelf (COTS) technology and extreme attrition rates. A 2023 report by the Royal United Services Institute (RUSI) highlighted the scale of this consumption, estimating that Ukrainian forces were losing approximately 10,000 UAS per month due to Russian Electronic Warfare (EW) and kinetic countermeasures [3]. This era is further defined by the FPV Revolution, where First Person View loitering munitions have democratized precision strike capabilities down to the squad level; an FPV drone costing roughly $400–$500 is now routinely used to disable Main Battle Tanks (MBTs) valued more than $2–four million. Furthermore, the integration of UAS feeds into networked fire control systems, such as GIS Arta, has drastically accelerated the Call-for-Fire loop, reducing the time from target acquisition to engagement from the standard 15-20 minutes to mere 45-60 seconds.

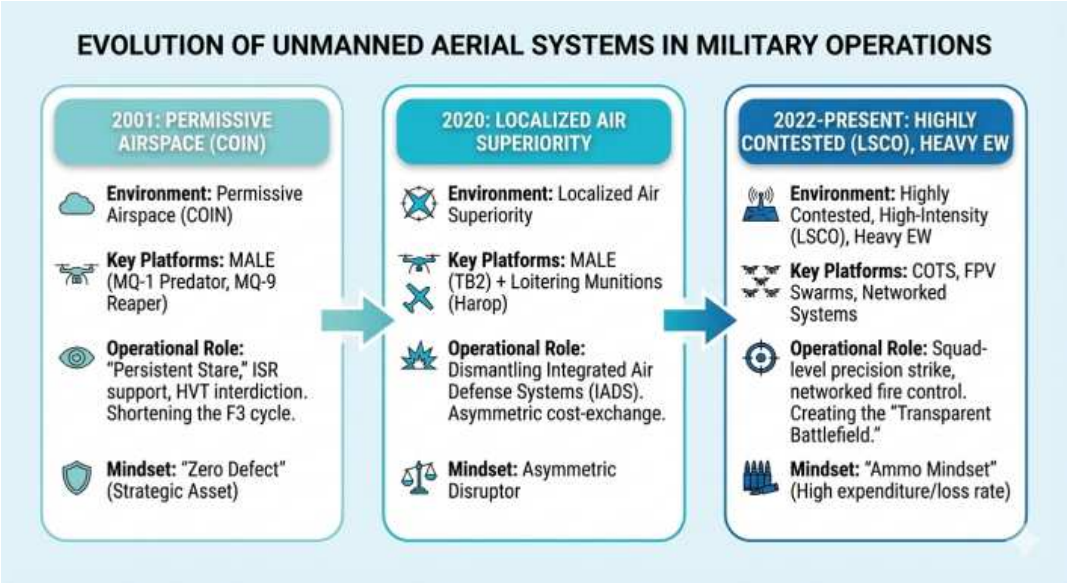


Fig. 1. Evolution of Unmanned Aerial Systems in Military Operations

In summary, the progression shown in the Figure 1 from the Predator (Epoch I) to the FPV swarm (Epoch III) illustrates a shift from quality/exclusivity to quantity/accessibility. The military mindset has evolved from a *Zero-Defect* approach—where losing a drone was a strategic incident—to an *Ammo* mindset, where drones are expended with the frequency of artillery shells. This shift creates the Transparent Battlefield, a condition that challenges the very foundations of maneuver warfare and concealment, issues that will be addressed in the subsequent chapter.

2. CONCEPTUAL AND OPERATIONAL CHALLENGES TO MILITARY ART IN THE CONTEXT OF UAS PROLIFERATION

The proliferation of Unmanned Aerial Systems necessitates a fundamental re-examination of the principles of war as defined in classical military theory. While the physical laws of ballistics remain constant, the operational environment in which they are applied has undergone a radical transformation. This chapter argues that the ubiquity of UAS challenges three core pillars of military art: the feasibility of concealment (Signature Management), the tempo of decision-making (the OODA Loop), and the geometric application of force (Mass vs. Dispersion).

2.1 The Erosion of Concealment: The Transparent Battlefield Phenomenon

For centuries, military maneuvers relied on the *Fog of War* and the terrain's ability to mask force build-up. The integration of networked UAS equipped with multi-spectral sensors (thermal, infrared, and optical) has effectively dissipated this fog, creating a condition increasingly referred to by strategists as the *Transparent Battlefield* (see Figure 2). In this environment, the traditional adage *if you can be seen, you can be killed* has evolved into an operational certainty with terrifying speed. The operational challenge lies in the fact that concealment is no longer a function of breaking the visual line of sight but requires masking across the entire electromagnetic spectrum. The operational reality observed in Eastern Ukraine demonstrates this lethality; a comprehensive study by the Royal United Services Institute (RUSI) noted that the life expectancy of a radio unit or artillery battery that remains static after firing is approximately three minutes before counter-battery fire, directed by UAS, engages the position [4].

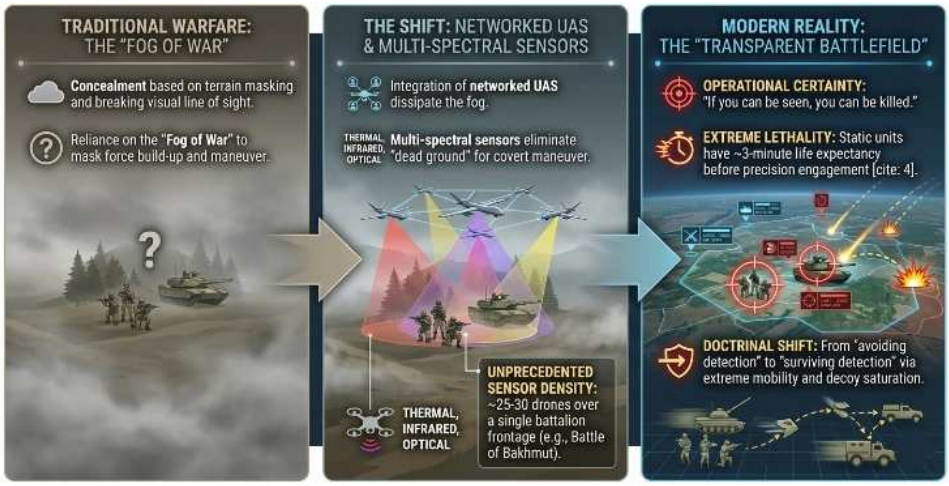


Fig. 2. The Transition from Fog of War to Transparent Battlefield

Furthermore, the density of sensors is unprecedented; during the height of the Battle of Bakhmut, combatants reported an average of 25 to 30 drones operating simultaneously over a single battalion frontage, effectively eliminating any *dead ground* for covert maneuver. Consequently, the doctrinal emphasis must shift from *avoiding detection*, which is becoming statistically impossible against a peer adversary with thermal capabilities, to *surviving detection* through extreme mobility and decoy saturation.

2.2 OODA Loop Compression and the Onset of Hyper-Warfare

The second major disruption concerns the temporal dimension of warfare, specifically Colonel John Boyd's Observe-Orient-Decide-Act (OODA) loop. In traditional doctrinal models, the Observe phase was the bottleneck, constrained by the speed of human scouts or the latency of satellite imagery. UAS proliferation has inverted this dynamic, creating a deluge of real-time data that threatens to overwhelm the Orient and Decide phases. The integration of software solutions, such as the Delta situational awareness system used by Ukrainian forces, allows for the fusion of UAS feeds directly onto the digital maps of unit commanders. This

integration has compressed the sensor-to-shooter cycle to levels previously unattainable.

Operational data indicates that the time required to identify a target, process the coordinates, and execute an artillery strike has dropped from the NATO standard of 10-15 minutes to as little as 60 seconds when using integrated UAS-Artillery reconnaissance complexes [5]. This acceleration forces commanders to delegate lethal authority to lower echelons to keep pace with the engagement tempo. As highlighted in recent studies on future warfare, this acceleration risks pushing operations into a state of *Hyper-Warfare*, where tactical engagements occur faster than the operational command structure can process, necessitating the use of AI-assisted target recognition algorithms to manage the cognitive load.

2.3 The Force Protection Paradox: The Dilemma of Mass vs. Dispersion

Perhaps the most acute operational challenge is the *Force Protection Paradox*, which fundamentally threatens the viability of mechanized maneuver. The Principle of Mass (or Concentration of Force) dictates that combat power must be concentrated at the decisive point to achieve a breakthrough. However, in an environment saturated with UAS-directed artillery and Loitering Munitions (LMs), any static concentration of armored vehicles creates a *sensor-magnet* vulnerability that inexpensive UAS can exploit with disproportionate lethality. The sheer volume of anti-armor threats is illustrated by the visually documented loss of over 2,600 main battle tanks by Russian forces in Ukraine by late 2023, a significant percentage of which were disabled or destroyed not by opposing tanks, but by top-attack munitions and FPV drones targeting the vulnerable engine decks and turret rings [6].

This asymmetry is stark; a $400 FPV drone carrying an RPG warhead can effectively mission-kill a $4 million T-90M tank, representing a cost-exchange ratio of 1:10,000. This reality forces a doctrinal dilemma: commanders must disperse assets to minimize the probability of detection and strike, yet effective offensive operations still require physical concentration. Resolving this paradox requires a new operational art based on pulsed operations—rapidly converging for a specific strike window and immediately dispersing—facilitated by the precise synchronization that only UAS-enabled networks can provide.

3. THE TRAINING PARADIGM SHIFT: INTEGRATING UAS INTO MISSION PLANNING, PREPARATION, AND EXECUTION

The contemporary defense and commercial aviation landscape is witnessing a paradigm shift, characterized by the exponential proliferation of Unmanned Aerial Systems (UAS). Governments and private enterprises alike are engaging in an aggressive procurement strategy, prioritizing the acquisition of hardware at a rate that far outpaces the development of the human capital required to operate it effectively. This chapter posits that the current trajectory—defined by a *hardware-first* mentality—is unsustainable. To fully realize the strategic and operational potential of drone technology, a decisive pivot is required: the focus must shift from the mere accumulation of airframes to the rigorous education, training, and retention of capable operators. As the data suggests, the limiting factor in modern drone warfare and commercial application is no longer the machine, but the mind behind it.

The global appetite for UAS hardware has reached unprecedented levels. In the commercial sector, the market size for drone technology reached approximately USD 41.79 billion in 2025 and is projected to expand at a Compound Annual Growth Rate (CAGR) of 13.9% through 2030 [7]. Similarly, on the battlefield, the scale of consumption is staggering. Reports indicate that in high-intensity conflicts such as Ukraine, individual brigades are consuming hundreds of FPV drones per month, a figure that dwarfs traditional procurement targets [6]. However, this influx of hardware masks a critical vulnerability: a chronic shortage of qualified personnel. While the U.S. Federal Aviation Administration (FAA) reported over 848,000 active pilots at the end of 2024, the specific certification pipeline for remote pilots has struggled to keep pace with the explosion in hardware registration and operational complexity [8]. This gap is not merely numerical

but qualitative. As drone systems evolve from simple surveillance tools to complex, multi-domain assets, the cognitive burden on operators increases. The *buy first, train later* approach has resulted in a landscape where sophisticated platforms sit underutilized or are operated by personnel lacking the deep tactical and technical proficiency to maximize their efficacy.

Therefore, this chapter argues that the true measure of drone capability is not the number of airframes in a hangar, but the depth of knowledge in the operator's mind. The current imbalance—characterized by frantic procurement and insufficient education—threatens to undermine the strategic advantages promised by UAS technology. A realignment of priorities is essential: investment in drone education, simulation training, and operator welfare must match, if not exceed, investment in hardware. Only by cultivating a generation of highly educated, resilient, and tactically proficient operators can we bridge the gap between technological potential and operational reality.

3.1 The Strategic Deficit: Analyzing the Gap Between Hardware Capabilities and Operator Proficiency

The central paradox of the modern drone ecosystem is that while the platforms have become exponentially more capable, the systems for generating the human capital to operate them have remained dangerously static. A *hardware-first* procurement strategy—common to both Western defense ministries and commercial enterprises—has created a strategic deficit: a surplus of sophisticated airframes matched with a scarcity of operators capable of exploiting their full potential. This subchapter analyzes the structural and pedagogical failures that have widened this gap, arguing that the current operator designation is frequently a misnomer for what is, in practice, often merely a monitor of automated systems.

A pervasive misconception driving the under-investment in training is the belief that advanced flight stabilization and partial autonomy reduce the need for skilled operators. In reality, automation does not eliminate human error; it merely shifts the cognitive burden from manual control (stick-and-rudder skills) to system management (decision-making, troubleshooting, and multi-domain integration).

3.1.1 The Cognitive Bottleneck: Operator Saturation

While the barrier to entry has been lowered, the operational ceiling has been raised. Modern drone operators are no longer simple pilots; they are intelligence managers, concept briefly shown in Figure 3. A single operator may be responsible for:

- Piloting the aircraft (often in non-line-of-sight conditions).
- Managing the payload (gimbal control, thermal imaging, zoom).
- Monitoring battery voltage and radio link quality.
- Deconflicting with other air traffic.
- Interpreting data for real-time tactical decisions.

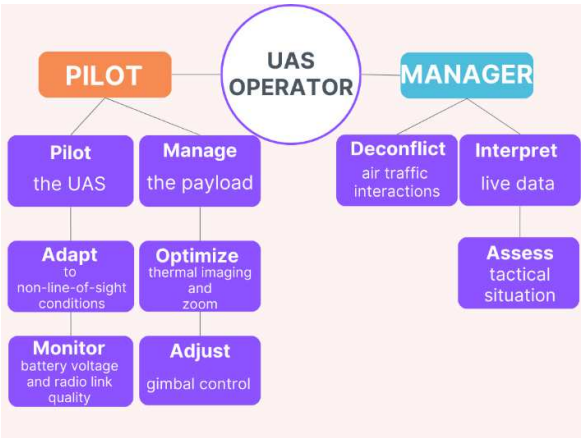


Fig. 3. Modern UAV Operator Responsibilities

Recent studies on cognitive load indicate that this multi-tasking saturation is a primary driver of accidents. Research published in IEEE Xplore [9] highlights that as automation levels increase, operator engagement drops, leading to a startle response when the system fails and manual intervention is suddenly required. The operator, lulled into complacency by the machine's autonomy, lacks the muscle memory to react, leading to preventable crashes.

3.1.2 The Attrition of Inexperience: Lessons from the Battlefield

The military consequences of this educational deficit are quantifiable and severe. In the ongoing conflict in Ukraine, the *churn* of hardware is inextricably linked to the *churn* of operators. While procurement focuses on delivering thousands of First-Person View drones, reports from the front lines indicate that the average life expectancy of a tactical drone is often measured in flights, not hours.

The reliance on short, 2-to-4-week training cycles for military operators creates a tactical debt. Operators are deployed with enough knowledge to launch the system but insufficient training to employ it effectively against a peer adversary, resulting in the waste of valuable assets.

The *hardware-first* approach proved to be economically inefficient. A high-end commercial enterprise drone (e.g., DJI Matrice 350 RTK or equivalent) costs upwards 10,000 EUR. A single crash caused by an untrained operator erases that capital investment instantly. Conversely, a robust simulator training program—which allows operators to crash thousands of times virtually for zero cost—represents a fraction of the hardware budget.

3.2 The Invisible Cockpit: Psychological and Physiological Realities of Remote Operations

While chapter 3.1 addressed the tactical deficit created by the hardware-first mentality, this section examines the human deficit. A critical failure in contemporary drone education is the neglect of the operator's psychological and physiological well-being. The popular vernacular often dismisses drone operations as video game warfare - sanitized, detached, and physically safe. This reductionist view, often referred to as the *PlayStation mentality*, is dangerously misleading. The removal of physical risk to the pilot has been replaced by a unique and corrosive set of psychological stressors that current training curricula fail to address.

Unlike manned aviation, where pilots often fly at high speeds and high altitudes, delivering ordnance and immediately departing the area, drone operators linger. They maintain a persistent stare over targets for hours or days. This capability creates a phenomenon known as high-resolution intimacy. Operators often observe the daily patterns of life of their targets (e.g., watching them interact with families, eat, and sleep) before a lethal engagement. Furthermore, they are often required to conduct Battle Damage Assessment (BDA), which involves remaining on station to scrutinize the aftermath of a strike in graphic detail. This prolonged visual proximity, combined with physical distance, creates a distinct pathway for Moral Injury—a psychological trauma resulting from witnessing actions that transgress deeply held moral beliefs.

Studies indicate that the rate of Post-Traumatic Stress Disorder (PTSD) among drone operators is statistically comparable to that of manned aircraft pilots deployed in theater, despite the drone operators never leaving their home base [10]. The *distance* does not insulate the mind from the reality of violence; the HD video feed often amplifies it.

A defining characteristic of remote operations, particularly in military contexts, is the lack of a traditional deployment cycle. A deployed soldier decompresses with their unit after a mission, sharing a collective processing of trauma. A drone operator, conversely, experiences a jarring commute to war. They may conduct a high-intensity lethal strike or witness traumatic events during an 8-hour shift, and 30 minutes later, be sitting at a dinner table with their spouse and children.

This rapid psychological switching requires a level of compartmentalization that few humans possess naturally. The 2026 National Defense Authorization Act (NDAA) explicitly recognizes this vulnerability, calling for mandated psychological resiliency training for operators to combat the specific stressors of this dual existence. Current educational pipelines, however, focus almost exclusively on systems operation, leaving operators ill-equipped to manage the cognitive dissonance of their daily lives.

Beyond the psychological toll, the physiological demands of remote operations are frequently underestimated. Drone operation is a sedentary but cognitively intense activity. Operators suffer from vigilance decrement, a decline in the ability to detect signals or targets over prolonged periods of monitoring. The physical environment of the Ground Control Station (GCS) contributes to this degradation. Shift Work Sleep Disorder is rampant in 24/7

drone operations, leading to chronic fatigue that directly impacts decision-making capabilities. In the commercial sector, where solo operators may fly back-to-back missions for industrial inspection, the cumulative effect of eye strain and mental fatigue leads to a degradation in situational awareness, increasing the likelihood of accidents.

The failure to integrate human factors into drone education is a strategic liability. Buying more drones does not solve the problem if the operators burn out at unsustainable rates. A robust educational model must include:

1. Resiliency training**:** Techniques for compartmentalization and stress management.
2. Bio-mathematical scheduling: Understanding fatigue limits to prevent operator error.
3. Ergonomic education**:** optimizing the physical interface to reduce strain.

As we transition to the next section, we will explore how these human limitations can be mitigated through the implementation of a standardized, tiered educational framework.

3.3 The Instructional Pivot: A Proposed Tiered Competency Framework

The prevailing hours-based certification model—where operator proficiency is measured simply by time spent in the air—is obsolete. It fails to account for the automation paradox: a pilot can log one hundred hours of flight time on a fully autonomous system without ever making a single critical decision or manual correction. To bridge the capability gap identified in the previous sections, this chapter proposes an immediate pivot to a Competency-Based Training (CBT) model. This framework prioritizes outcome over attendance. It structures education not around the platform (the hardware), but around the operational environment and the cognitive demands placed on the human. Below is an actionable, three-tiered curriculum designed to transform novices into tactically proficient operators.

3.3.1 The Three-Tier Educational Hierarchy

To move beyond the *hardware-first* mentality, procurement and training officers must adopt the following tiered progression. Hardware acquisition should only be authorized once the operator pipeline has demonstrated capacity at the corresponding tier described in Figure 4.

Tier I: Foundational Manual Proficiency (The *Stick* Skills)

The curriculum must begin by strictly decoupling the operator from reliance on automation, addressing the critical vulnerability where GPS jamming or compass failure leads to operator panic. Rather than relying on stabilization, certification at this level necessitates that operators demonstrate the ability to hover, navigate, and land in Attitude Mode (ATTI) without GPS or vision positioning assistance. True proficiency is defined by the operator's capacity to perform continuous, controlled maneuvers—such as banked figure-8s within a confined box—while managing environmental stressors like a 15mph crosswind component. Flight deployed hardware should be prohibited until these manual stick skills are verified in a simulator environment.

Tier II: Systems Management & Integration (The *Switch* Skills)

Once manual control is mastered, the education shifts to the complex cognitive burden of managing the payload simultaneously with the aircraft. This tier addresses the dangerous tendency for operators to fixate on the soda straw view of the camera feed, which often results in a loss of broader situational awareness and subsequent collisions. Training at this stage requires split-attention drills, where the operator is forced to track a moving target via the payload sensor while simultaneously navigating the aircraft through a complex 3D corridor. Furthermore, operators must be inoculated against technical failure through degraded link operations, learning to fly the map using only telemetry data when video feeds are compromised by lag or signal loss.

Tier III: Tactical & Cognitive Decision Making (The *Mind* Skills)

The apex of operator education prioritizes the ethical application of force and high-pressure decision-making over mere mechanical inputs. Technical pilots often fail in the field because they cannot process Rules of Engagement (ROE) under the immense psychological stress

of combat or critical infrastructure inspection. This tier introduces Opposing Forces (OPFOR) elements, such as electronic warfare jamming or rapid weather changes—to test the operator's adaptability. Crucially, this stage must include Ethical No-Go simulations, designed to induce ambiguity and force the operator to abort a mission based on safety parameters, ensuring that judgment is valued as highly as dexterity.

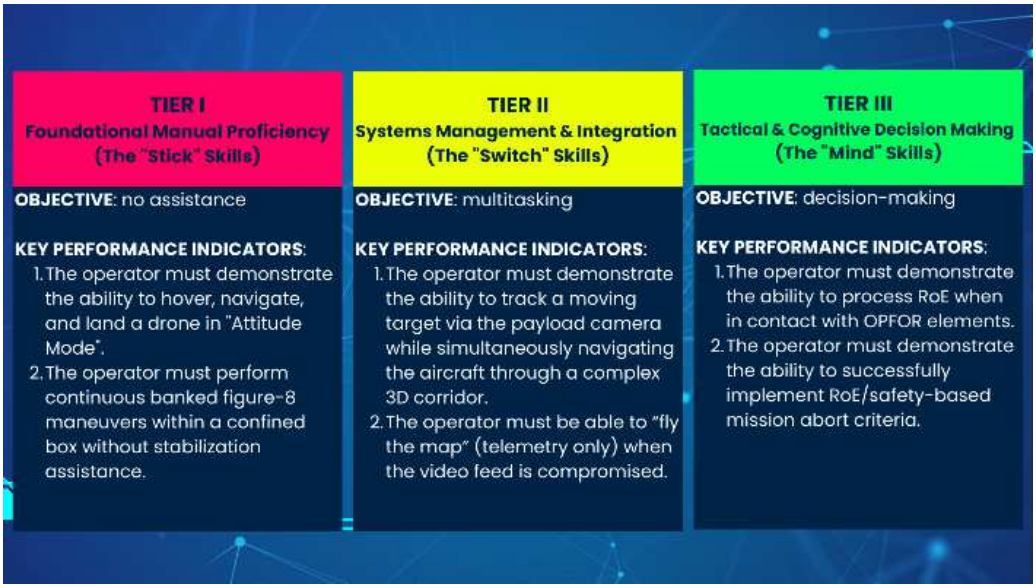


Fig. 4. Tier-based UAS Operator Education Program Framework

3.3.2 The Implementation Protocol: Actionable Mandates

To successfully integrate this framework, organizations must adopt the following mandates immediately. These are not theoretical suggestions but structural requirements for a modern drone program compiled according to Figure 5.

The *Simulator-First* Mandate

Recognizing that hardware is expensive but electrons are free, organizations must implement a 10:1 Simulation-to-Live ratio. For every hour spent flying a physical airframe, the operator must complete ten hours of high-fidelity simulation. This approach, supported by U.S. Navy studies, significantly reduces costs while increasing the retention of emergency procedures (US Naval Air Systems Command).

Standardization of Emergency Logic

To eliminate tribal knowledge, programs must codify a platform-agnostic Emergency Action Plan (EAP). This includes drills like the Blind Landing, where operators must return and land the drone using only telemetry data (height, distance, speed) with the video monitor disabled, simulating a total video link failure in a contested environment.

Crew Resource Management (CRM) for Remote Crews

Adopting aviation CRM standards is essential for complex environments. This mandates specific communication loops (e.g., Command given -> Command repeated -> Action taken) and trains visual observers (VOs) to actively manage the pilot's cognitive load by monitoring battery levels and signal strength, allowing the pilot to focus exclusively on maneuvering.

The transition from a hardware-centric procurement model to an education-centric operational model is not merely an option; it is a prerequisite for viability in the modern era. As demonstrated by the attrition rates in Ukraine and the commercial pilot shortages in the West, the bottleneck is human. By implementing the tiered framework and actionable protocols outlined above, organizations can inoculate themselves against the *hardware-rich, talent-poor* trap. We must stop buying capabilities we cannot fly and start training the minds that will decide the outcome of the mission.



Fig. 5. Implementation Protocol with Actionable Mandates for Tier-based UAS Operator Education Program Framewor

3.4 The Pan-Domain Response: Universal Adaptation to the Transparent Battlefield

The proliferation of UAS creates a *Transparent Battlefield* that necessitates a comprehensive adaptation across every military occupational specialty, moving beyond specialized Air Defense to a universal mandate of survival. For maneuver elements, this shift is visceral: Infantry must abandon traditional concealment for signature management and micro-dispersion to evade thermal sensors, while the Armored corps must transform tanks into mobile electronic fortresses equipped with organic jamming and hemispherical active protection. Simultaneously, the support branches face an equally radical evolution; Artillery must adopt extreme *shoot-and-scoot* protocols to survive compressed counter-battery timelines, while Engineers are compelled to standardize overhead protection against loitering munitions as a foundational architectural requirement.

Crucially, this adaptation extends to the logistical tail, where the era of mass supply convoys has ended. Logistics must fragment into *ant-hill* distribution models to deny the enemy high-value targets, and medical evacuation protocols must adjust to a reality where air superiority for helicopters is no longer guaranteed. Ultimately, the drone hegemony demands a cultural revolution where the distinction between front and rear vanishes. The response is not merely technical but doctrinal, requiring every soldier—from the rifleman to the truck driver—to function as an active sensor and defender within a unified, organic air defense network.

4. CONCLUSION – THE HUMAN ELEMENT AS THE DECISIVE ADVANTAGE

The preceding chapters have outlined a critical strategic vulnerability in the modern adoption of Unmanned Aerial Systems. We have demonstrated that the current global trajectory—defined by a hardware-first procurement frenzy—has created a dangerous asymmetry. While airframes have become exponentially more capable, the educational pipelines responsible for generating the human capital to operate them have remained stagnant, relying on outdated metrics of hours logged rather than decisions made. This concluding chapter synthesizes the arguments presented, reaffirming that in the era of robotic warfare and autonomous industry, the decisive advantage remains irrefutably human.

The central thesis of this work is that a warehouse full of advanced drones does not constitute a capability; it constitutes a liability if matched with an untrained workforce. The evidence from the battlefields of Eastern Europe and the commercial airspace of the West is unambiguous: the *churn* of hardware—driven by preventable crashes, electronic warfare susceptibility, and operator burnout—is an unsustainable economic and tactical burden. We must dismantle the illusion that automation eliminates the need for skill. As we have explored, automation merely shifts the burden from manual dexterity to cognitive management. The *Paper Pilot*, certified by regulation but untested by reality, is a failure of our own making. By continuing to prioritize the

acquisition of physical assets over the cultivation of mental resilience and tactical proficiency, organizations are essentially buying sophisticated targets rather than operational assets.

Looking forward, the solution is not to reject technology, but to better integrate humans into it. The future of UAS operations lies in a symbiotic relationship where human judgment guides artificial intelligence. However, this relationship requires an operator who is not merely a monitor, but an active, educated manager of systems.

The era of buying your way out of the problem is over. The hardware gap between competitors is closing; the technology is becoming democratized and commoditized. The only competitive advantage left is the quality of your personnel.

Therefore, this article concludes with a call for a Doctrine of Educational Priority. This doctrine dictates that for every dollar spent on a new airframe; a proportional investment must be made in the simulation, psychological support, and tactical education of the person holding the controller. We must stop counting drones and start counting capable operators. Only then will the promise of this technology be fully realized, transforming it from a fragile novelty into a robust, decisive instrument of power.

5. REFERENCES

[1] Deptula, D., *Direct Attack: Enhancing Counter-land Operations*, Air & Space Power Journal, ISSN 0897-0823, Maxwell AFB, 2010.

[2] Shaikh, S., Rumbaugh, W., *The Air and Missile War in Nagorno-Karabakh: Lessons for the Future of Strike and Defense*, https://www.csis.org/analysis/air-and-missile-war-nagorno-karabakh-lessons-future-strike-and-defense.

[3] Watling, J., Reynolds, N., Meatgrinder: *Russian Tactics in the Second Year of Its Invasion of Ukraine*, https://rusi.org/explore-our-research/publications/special-resources/meatgrinder-russian-tactics-second-year-its-invasion-ukraine.

[4] Cancian, M. F., *The Future of the US Industrial Base and the War in Ukraine*, Center for Strategic and International Studies (CSIS), Washington D.C., 2023.

[5] Mitzer, S., Oliemans, J., *Attack On Europe: Documenting Russian Equipment Losses During The 2022 Russian Invasion Of Ukraine*, https://www.oryxspioenkop.com/2022/02/attack-on-europe-documenting-equipment.html

[6] Watling, J., & Reynolds, N. (2025). *Tactical Developments During the Third Year of the Russo–Ukrainian War*. Royal United Services Institute (RUSI).

[7] Mordor Intelligence. (2025). *Drones Market Size & Share Analysis - Growth Trends & Forecasts (2025 - 2030)*. Mordor Intelligence.

[8] Federal Aviation Administration (FAA). (2025). *FAA Aerospace Forecast Fiscal Years 2025–2045*. U.S. Department of Transportation

[9] IEEE Xplore. (2025). *UAV Operators' Cognition and Automation: Comprehensive Measurements*.

[10] Chappelle, W., et al. *Prevalence of PTSD in Remotely Piloted Aircraft Intelligence Personnel*. U.S. Air Force School of Aerospace Medicine

Schimbare de paradigmă conceptuală, acțională și de instruire în contextul proliferării sistemelor aeriene fără pilot la bord în operațiile militare moderne

Rezumat: Acest articol susține că integrarea sistemelor Aeriene Fără pilot (UAS) a perturbat fundamental războiul modern, tranziționând drone de la facilitatori strategici la împușcături omniprezente. Urmărește această evoluție prin trei epoci operaționale, culminând cu Hyper-Warfare, caracterizată prin compresie extremă a buclei OODA și câmpul de luptă Transparent, unde ascunderea este învechită. Cu toate acestea, textul susține că o strategie predominantă de achiziții publice a creat un decalaj critic în ceea ce privește capacitatea. În timp ce cadrele aeriene au avansat, educația operatorilor rămâne stagnantă, ducând la saturație cognitivă, decretare de vigilență și epuizare psihologică. Articolul propune un pivot strategic pentru un model de Formare Bazată pe Competențe, subliniind o ierarhie educațională pe trei niveluri—Manual Proficiency, Systems Management și Tactical Decision Making—pentru a restabili elementul uman ca avantaj decisiv în conflictul autonom.

Constantin GRIGORAȘ, Professor, PhD, "Nicolae Bălcescu" Land Forces Academy of Sibiu, grigoras.constantin@armyacademy.ro, +40 740 513 612, 3-5 Revolutiei Street, Sibiu, Romania.

Ștefan-Cristian PETRE, Platoon Commander, "Nicolae Bălcescu" Land Forces Academy of Sibiu, petre.stefan@armyacademy.ro, +40 731 614 824, 3-5 Revolutiei Street, Sibiu, Romania.