"Henri Coandă"
Air Force Academy
Brasov, Romania

Students' International Conference
AFASTUD 2025 (25th Edition)

Communicating across Cultures

May 21 – 23, 2025
Braşov, Romania

"Henri Coandă" Air Force Academy Publishing House
ISSN, ISSN-L: 2360-0152

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C O N T E N T S

Engineering

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TECHNIQUES APPLICABLE IN PREVENTING MUSCULOSKELETAL INJURIES IN HELICOPTER PILOTS

Andrei PRICOP

Coordinator: Assist. Prof. **Ioan Andrei PETRESCU**

Institute of Military Medicine, Bucharest, Romania

Abstract: *One of the most common challenges faced by aviation medicine is the high prevalence of musculoskeletal injuries among crew members operating rotary-wing aircraft (RWA). These injuries arise due to a combination of factors inherent to the nature of helicopter flight. One significant contributor is the exposure to whole-body vibrations (WBV), which are generated by the aircraft's engines, rotors, and aerodynamic forces. These vibrations affect both passengers and pilots, leading to discomfort, fatigue, and potential long-term musculoskeletal complications. In addition to WBV, various occupational conditions further exacerbate the risk of injury. Helicopter pilots and crew members often experience prolonged work durations and extensive flight hours, which can contribute to cumulative stress on muscles and joints. The physical demands of flight, including rapid accelerations and decelerations, can place strain on the spine and other musculoskeletal structures. Furthermore, the mandatory use of heavy helmets and headgear, while essential for protection and communication, can lead to additional strain on the neck and shoulders, especially during extended missions. Another crucial factor is the awkward posture that pilots must maintain during flight, often due to the design of the cockpit and the necessity of maintaining situational awareness while operating complex controls. This article aims to explore the relation between musculoskeletal injuries and helicopter piloting, as well as determining techniques for preventing or alleviating such injuries.*

Keywords*: aircraft; musculoskeletal injuries; whole-body vibrations; flight.*

1. INTRODUCTION

In spite of the immense technological progress achieved since the flight of the first "gyroplane" in 1907, helicopter pilots still face the same extreme occupational conditions that elevate their risk of pre-flight, in-flight, and post-flight musculoskeletal pathology and disability. These issues manifest as weakened concentration and situational awareness, grounding, inability to perform in-flight maneuvers, impaired motor control and posture, pain, lost work or training time and retirement (Phillips, 2011; Shiri et al., 2015; Posch et al., 2019). Evidence shows that many pilots do not report pain and discomfort in fear of losing flight status (Kikukawa et al., 1995; Kerstman et al., 2012; Posch et al., 2019).

Musculoskeletal injuries are caused by a number of factors, ranging from: vibratory loading, eccentrically loaded head-supported mass (HSM), movements required for environmental awareness, high-g forces acting parallel to axis of the spine (high-Gz, Figure 1), cockpit layout or equipment configuration (Figure 2), fatigue and overuse and physical training (Jones et al., 2000).

Theoretical solutions to these problems include: exercise and stretching, re-design of cockpit and equipment, helmet re-configuration and counterweights, and anti-vibration seating.

2. IN-DEPTH ANALYSIS OF THE MAIN CAUSES AND MANIFESTATIONS

In order to better understand the problem at hand we must examine its main causes. They are, in order of regularity, the following: whole-body vibrations (WBV), positive gravitational forces and inadequate equipment as well as uncomfortable cockpit arrangement and many other lesser important factors. In consequence, the most common musculoskeletal pathologies are associated with the spine, ranging from: lumbar or cervical back pain, exaggerated muscle fatigue and hernias.

2.1 Whole-body vibrations

As previously stated, WBV are one of the main causes of musculoskeletal disorders, but that is not their only type of manifestation. Vibrations can also be transmitted to the eyes and affect manual tracking performance. Moreover, the noise associated with vibrations exacerbates hearing loss. The effects are also cognitive, as long exposure leads to reduced performance and attention when piloting and drowsiness. Other physical disorders caused by WBV can be of gastrointestinal, cardiovascular, neurologic or reproductive nature.

Most significant for our study are the effects of WBV on the musculoskeletal complex of the spine, which result in the appearance of lower-back pain (LBP). Vibrations can cause the spine to undergo tension, compression, flexion and rotation, all of which can activate the back muscles and lead to fatigue. At a vibrational frequency of 4.5 Hz, measurement of muscle oxygenation shows decreased oxygen levels, reduced metabolic activity and blood flow (Li et al., 2012). At a frequency of 5 Hz, Electromyographic studies of the spinal erector muscles indicate an increase of fatigue, which is supported by reduced muscle oxygenation (Pope et al., 1998, Blüthner R et al., 1993, Hansson et al., 1991).

In the military field there is a cohort study on helicopter pilots which found an association between cervical and lumbar degenerative changes and total flight hours (Byeon et al., 2013). The study included questionnaires, radiographic examinations, statistical analyses and subjects consisting of 186 helicopter pilots and 94 clerical workers, who were used as a control group. Upon conclusion, the results showed an association between lumbar and cervical back pain and age, which was common for both groups, in addition to the obvious presence of back pain in helicopter pilots.

The issue of whole-body vibrations has already been addressed in the rotary-wing aircraft community with the introduction of anti-vibrational seats (Phillips, 2011), with studies proving their efficacy in reducing muscle strain (Wright Beatty et al., 2018).

2.2 Positive gravitational forces, cockpit and equipment

When examining positive gravitational forces and acceleration, the only significant component which has a negative effect on the body is the vertical and positive one, referred to as +Gz (Fig. 1). Similarly to WBV, high positive Gz forces are exerted upon the spines of the pilots, leading, in time, to intervertebral disc degeneration, hernias, nerve damage and general back pain. Although modern helicopters only reach 4 G forces (significantly lower than G forces developed by airplanes), the negative effects are still felt over time.

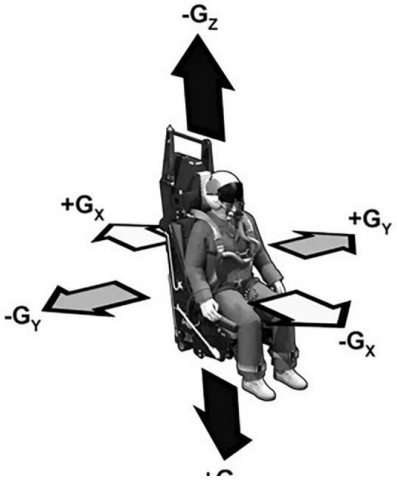

FIG. 1 Gravitational axes with respect to aircraft pilot. (Air force training manual)

Furthermore, equipment like helmets or night-vision goggles increase the weight tolerated by the spine. The compressive forces of flight, as well as heavy equipment, increase the weight supported by the vertebrae, leading to the compression of the intervertebral disc and its components, specifically the pulpous nucleus, resulting ultimately in hernias (Fig. 2). One study in particular (Posch et al., 2019) has shown that, upon exceeding 150 hours wearing night vision goggles, 90% of helicopter pilots report neck pain. Besides adding additional weight, night-vision goggles restrict the pilot's field of vision, leading to more exaggerated head movement to maintain situational awareness, thereby increasing neck strains (Thoolen and van den Oord, 2015).

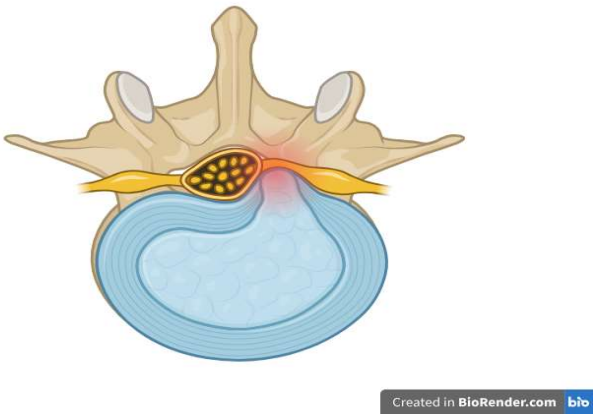

FIG. 2 Cross section of a lumbar vertebra with herniated disc

Moreover, due to cockpit structure or general shape of the seat (Fig. 3), the pilot may be forced to assume more unnatural positions, which increase the damage done to the spine by different forces. One such posture is aptly called "helo hunch" and appears when flying in a nose-up attitude, the pilot being forced to hyperextend his/her neck in order to see out the windscreen (Phillips, 2011). Another element that is problematic is represented by flight control position. On some less ergonomic aircrafts the position of the control panel forces the pilot to lean forward and perform "reaching" motions, which combined with other factors, leads to more discomfort and pain.

Most common is shoulder pain (43.3%) (Posch et al., 2019) and can be interpreted as a number of pathologies, mainly relating to connective tissue. Two types of injuries reported by pilots are: shoulder impingement and tendonitis.

On the one hand, shoulder impingement occurs when the rotator cuff tendons or bursa (a fluid-filled sac that reduces friction) become compressed between the bones of the shoulder, leading to pain and inflammation. On the other hand, tendonitis is the inflammation or irritation of a tendon, typically due to repetitive motion, overuse, or sustained strain. In the shoulder, it commonly affects the rotator cuff or biceps tendons, leading to pain, weakness, and reduced range of motion. These two complications usually appear in helicopter pilots due to poor control panel configuration, as briefly described. Besides performing "reaching" motions which we described, pilots are forced to maintain these positions for undetermined amount of time. Some controls are of major importance and as such they require repetitive movement. Although these factors are inconsequential in the moment, over time they will put a strain of the shoulder, leading to pain.

Another body part affected (although less) is the wrist, which can be afflicted with carpal tunnel syndrome (CTS). The carpal tunnel is a narrow passageway in the wrist surrounded by bones and containing ligaments and the median nerve. When the nerve is compressed, the person will usually feel tingling and numbness in the thumb and finger and eventually pain in the wrist. CTS shares many of its causes with shoulder pain: poor wrist posture, repetitive movements, but also vibration exposure (Deal et al., 2020).

FIG. 3 The cockpit of a IAR 330 Puma SOCAT helicopter.

3. REMEDIES, TREATMENT AND PREVENTIVE MEASURES

Given the biomechanical nature of these pathologies, many can be prevented through regular physical exercise and structured training. Research has identified a specific exercise for alleviating chronic neck pain (Murray et al., 2015). This exercise is performed while lying on the back, with the head resting on the floor for support. Patients are instructed to extend their head in a cephalic direction and, upon reaching full extension, return it to the starting position through a caudal flexion movement. During the initial training phase, a towel is placed under the neck for added support. As patients progress, they are encouraged to gradually lower the towel's height to increase the exercise's intensity, thusly improving their neck.

Other preventive measures which don't include physical exercise are reconfigurations of the cockpit. The issue of uncomfortable positions can be solved by making the aircraft more ergonomic. This would include changes to the control layout, seat arrangement and position and general cockpit structure. The problem of seats is also brought up when discussing transmission of whole-body vibrations. Studies have focused on solutions to this problem such as (Phillips, 2011): seat cushions and anti-vibration hydraulic systems. Some rotary-wing aircrafts have also addressed the issue of positive gravitational forces by slightly angling their seats. While this does mitigate the effects of positive gravitational forces, it also reduces visibility, forcing the pilot to stretch their necks, leading to other problems.

As we mentioned in the previous chapter, helmets and night-vision goggles add to the risk of developing neck pain. One answer to this problem lies in the introduction of counter weights (Fig. 4). According to one article (Harrison et al., 2007), the use of counter weights decreases muscle fatigue of the trapezius muscle responsible for maintaining head balance. An alternative involves a spring-loaded mechanism which lowers the inertia of the head (Smith, 2016). Lighter materials should also be considered when designing helmets, but not in exchange of pilot safety. Worthy of consideration are composite materials like carbon fiber and Kevlar, an example of use being helmets based on polymer matrixes reinforced with carbon nanotubes and aramid fabric (Daungkumsawat et al., 2020).

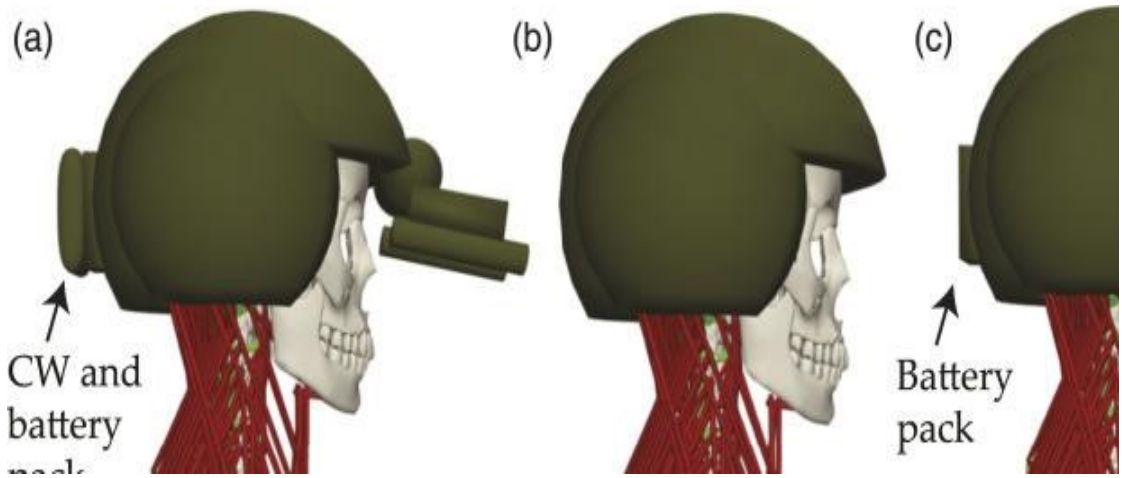

FIG.4 Cervical spine model with a visual representation of a standard helmet with variations including night-vision goggles and counterweights

4. CONCLUSIONS

Understanding the medical problems faced by pilots is of major significance when analyzing performance, especially in the 21st century, when the probability of conflict keeps rising. Considering the importance of helicopters on and outside of the battlefield, modern aviation medicine and engineering should seek to solve the complications mentioned in this article and improve on current working conditions. After all, the number of healthy pilots a nation can send in the sky will influence its degree of air dominance. In order to achieve a better grasp of the problem at hand further investigations and studies are required into the cause-and-effect relationship between physical risk factors and health complications, as well as innovation in the process of design and production of rotary-wing aircrafts and equipment.

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BEYOND THE CHECKLIST: FLIGHT SAFETY, NON-TECHNICAL SKILLS AND THE CADET PILOT JOURNEY

Cristian-Ioan CĂRĂBINEANU, Vlad Ștefan ALEXANDRU, Gabriel BALAN

Coordinator: Cdor **Oliver CIUICĂ,** PhD

"Henri Coandă" Air Force Academy, Brașov, Romania

Abstract: *This paper explores the development of flight cadets into professional aviators through the lens of safety, instructional design, human factors, and psychological preparedness. Referencing aviation safety and educational theory models, the discourse describes how cadets move from learner to practitioner via dedicated training and the re-orientation of core beliefs. The Swiss Cheese Model, the five hazardous attitudes as identified by the FAA and non-technical skills (NTS) are key to understanding this development. Specific attention is paid to the incorporation of critical thinking, situational and systems awareness in aviation culture. While developing a reflective practice, unpacking mental models, and developing resilience, cadets will increase their personal competence and safety as a team. Focusing on systems thinking and culture of discipline and the psychological aspects of flying, we stress the direct and indirect relationship between proactive safety attitudes and self-awareness in extremely dangerous operational conditions.*

Keywords*: Aviation Safety, Swiss cheese Model, Non-Technical Skills, Hazardous Attitudes*

1. INTRODUCTION

The aviation industry is one in which the potential for error is slim - and the effects when you do fail can be deadly. Therefore, flight safety is not only a duty but a value and a goal. It includes risk mitigation, system reliability, human factor, and procedural robustness. The safety concerns of flying include aspects such as avoiding accidents and minimising their effects. According to the International Civil Aviation Organization (ICAO) (2009) safety is the "state in which risks associated with aviation activities are reduced and controlled to an acceptable level."

This bar is even higher in military flying, where the mindset is one of unrelenting vigilance, responsiveness, and a culture where safety is paramount. The metamorphosis of cadets into aviators hinges on driving this safety mindset practically and psychologically deep into their training. A sound pilot is not simply skilled in operating their aircraft, but also sensitive and knows how to communicate with others as well as to assess a situation. So, ensuring safe flights has to be a whole-of-aviation approach to mindset, training, systems and culture.

2. THE SWISS CHEESE MODEL

James Reason's Swiss Cheese Model (1990) conceptualizes accident causation as a series of organizational and human layers, each with potential weaknesses or "holes." These holes represent unsafe acts or conditions in latent (cumulative and usually outdated) or active (at the time of the accident) failures.

Harmonization of these is a challenge as interactions in one layer often become coincident in other layers, where incidents can happen.

The model makes this assumption that defenses, barriers and safeguards are not perfect. Every slice of cheese is a defense, and every hole is a potential vulnerability. Crucially, the hole alignment across layers is often due to system-level deficiencies, not mere human error. This model is particularly valuable for cadets as it provides a framework that illustrates how safety violations are rarely due to a single mistake, but are instead the point at which several errors intersect or build up.

This model is also useful for aircrew training where it can be used to train cadets to appreciate their role within a wider system. Every task, checklist, and communication protocol is another slice of cheese intended to catch or better yet, prevent a mistake. By appreciating how each layer contributes to overall safety, cadets learn the importance of:

·Cross-checking and redundancy

·Adherence to standard operating procedures (SOPs)

·Encouraging open error reporting

·Supporting a culture of collective responsibility

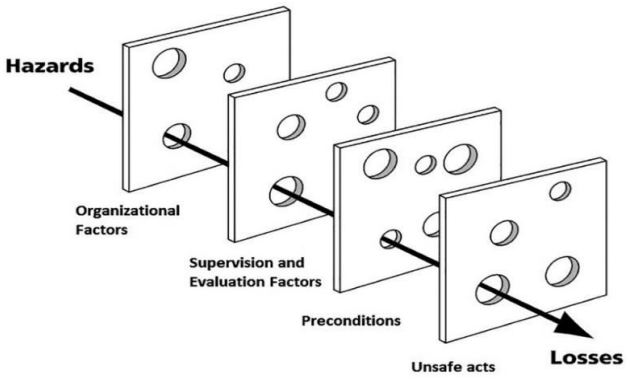

FIG.1 An illustration of swiss-cheese model

Understanding the Swiss Cheese Model teaches you to think in terms of containing the problem, banding together as a team, and doing anything you can to prevent further spread of the issue. It teaches you a little about systemic thinking and personal responsibility. It illustrates the value of strong systems, human watchfulness, and a no-blame atmosphere to foster ongoing learning and growth.

3. INSTRUCTION, LEARNING, AND DISCIPLINE

Quality flight training is a synergistic learning experience that integrates technical knowledge with the growth of the individual person. The instructor is ultimately the most important mentor the student will have during his or her training experience, not just as an expert, but as a role model on what the student will strive to achieve in terms of professional behavior. The learning environment has to be favorable to curiosity, feedback, and respect for one another - factors that build confidence and skill.

Discipline, mistaken for rigidity, is actually an inward dedication to consistency, excellence and accountability. It is the trait that keeps pilots operating successfully at crunch time - execute the checklist, hold the procedures, lead with honor. Regularity, schedule, and oversight allow cadets to build the kind of self-discipline that is necessary for success in aviation.

3.1. The monkey paradigm: the dangers of blind obedience

The "Monkey Ladder" allegory—though not a scientific experiment—serves as a powerful metaphor in aviation culture. In the story, monkeys are conditioned to avoid a ladder not because of personal experience, but because of group behavior passed on without explanation. When new monkeys are introduced, they too adopt the behavior without questioning its origin, perpetuating a cycle of blind compliance.

In the aviation context, this illustrates how practices can persist without critical evaluation. For cadets, the lesson is clear: do not follow procedures blindly. Instead, strive to understand their purpose. This encourages:

- Constructive questioning
- Deeper learning
- Informed compliance

By fostering an environment where cadets can inquire and reflect, instructors help prevent the stagnation of outdated or misunderstood protocols, thereby enhancing operational intelligence and adaptability. This paradigm challenges cadets to understand the "why" behind the "what", reinforcing cognitive engagement with procedures. Blind obedience, while seemingly efficient, may hide latent safety issues that only critical thinking can uncover.

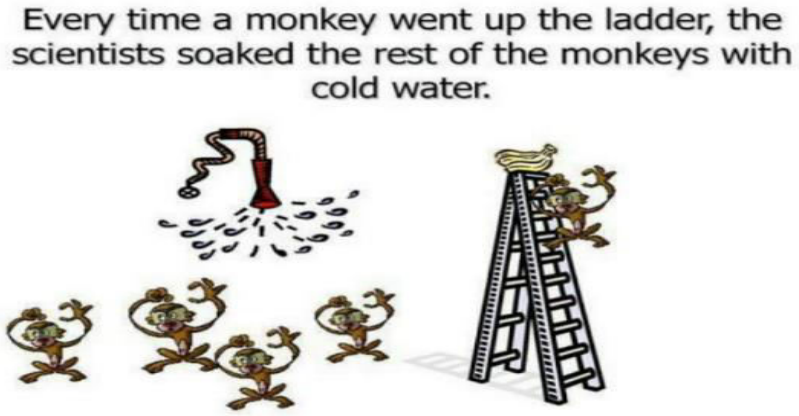

FIG. 2 An illustration of the monkey paradigm

3.2. The student mindset and hazardous attitudes

The FAA (2016) lists five hazardous attitudes mitigating flight safety. Here are the five most significant psychological traits that cloud the judgment and decision-making process:

1. Anti-authority – "Don't tell me what to do.".
    - Antidote: "Follow the rules. They are usually right."
    - This attitude involves a resistance to rules, procedures, or instructions. In a military environment where discipline and standardization are vital, disregarding authority can lead to serious safety breaches. Cadets must learn to respect regulations while understanding the rationale behind them.
2. Impulsivity – "Do something quickly!"
    - Antidote: "Not so fast. Think first."
    - Acting without thinking can result in rash decisions, especially under pressure. Cadets are trained to pause, assess the situation, and make deliberate, informed choices, even in time-critical scenarios.

3. Invulnerability – "It won't happen to me."
    - Antidote: "It could happen to me.".
    - This mindset leads to underestimating risks or believing that accidents only happen to others. Recognizing vulnerability fosters a more cautious and responsible approach to flying and enhances safety awareness.
4. Macho – "I can do it."
    - Antidote: "You'd be dumb to take risks."
    - Overconfidence can lead cadets to take risks they don't need to take to demonstrate their abilities. Military aviators have to find the confidence to know when to attack but also the humility to know when to seek help or pull back if pursuing a target is too unsafe.
5. Resignation – "What's the use?"
    - Antidote: "I'm not hopeless. I can make a difference."
    - A sense of helplessness or giving up can cause inaction during critical moments. Cadets are taught to stay engaged, trust their training and take initiative, even in challenging situations.

Recognizing these attitudes demands situational self-awareness as well as reflective practice. Cadets might engage in structured debriefing, journaling or solicited peer feedback to discover patterns of thinking that come up repeatedly. Once these attitudes are detected, instructors could help cadets learn to transform them by practicing the recommended antidotes.

4. NON-TECHNICAL SKILLS (NTS)

Non-technical skills are critical for the safe and efficient functioning of all types of aviation. They are not an add-on, but an integral part of flight safety and leadership. Key NTS include:

4.1. Communication skills

The first obstacle for student pilots to overcome is the gap between the authority of the instructor and the learner and local knowledge differences. It's up to the instructors in the end, but the cadets are supposed to point out when there's an unsafe situation, something has been done wrong or incorrectly. It requires respectful assertiveness–being willing to speak up or ask questions in a respectful way, without doubt and without fear that you are crossing some sort of invisible line. The cadets will have to learn ways of getting by rank, experience, and stress with professionalism, listening and respectful feedback. Use of standardized language, closed-loop communication, and respectful assertiveness is also stressed in order to promote understanding and prevent confusion.

4.2. Situational awareness

Situational Awareness is the continuous perception of the environment. Cadets learn the difference between perception and reality, how to control distractions and how to concentrate under stress. There's focus on scanning procedures, instruments and getting ahead of the plane. Identifying these subtle warning signals and being prepared for possible problems is crucial to being safe and making good decisions while flying.

4.3. Problem-solving and decision-making

When you're in a military cockpit, you need to make a decision in seconds and make it confidently. Whether coping with mechanical trouble or managing a dynamic mission scenario, cadets must exercise skills to analyze the situation, to assess options, and to act—all within the framework of military protocols and instructor guidance. Such skills

are developed through repetitive exposure to problem-solving in real time in flight and simulator training.

4.4. Leadership

Cadets are supposed to start learning to be leaders even as trainees. Leadership is more than power, it is about responsibility, professionalism, and setting a good example. In doing this, cadets not only learn how to take initiative, take on responsibilities and communicate constructively, but they also learn to be flexible, cooperative, courteous and respectful. A grasp of team dynamics, cultural sensitivity and credibility get you partway to leading effectively in future operational roles.

4.5. Stress management

Military flight school is tense by definition. Cadets are subjected to physical, mental and emotional pressures that include tough mission profiles, rigorous evaluation criteria, long days and a lot of pressure to perform. Developing resilience is key. Cadets learn ways to identify stress signals, use coping methods, and focus under stress. Equally important is the confidence to recognize when to cease training or to speak up with an instructor when fatigue or stress is presenting a risk to safety. The gain in cockpit management of stress is not only reflected by the optimised performance, but enhances military readiness and operational discipline.

4.6. Critique

The capacity to accept feedback, work through it and to find the right way to use it, is an integral part of the job as a military aviator. Every flight is debriefed and the cadet's performance is dissected and shortcomings identified. Cadets need to develop an attitude that accommodates criticism as a way to learn and not as a personal attack. Similarly, cadets are expected to self-evaluate and be honest in their self-reflection statements. This dynamic hones judgment, reinforces procedural compliance and grows the never-let-it-happen-again mentality demanded of military aviators.

5. CONCLUSION

Learning to fly at a professional level is not just about knowing how to handle your plane or aircraft. Instead, it's about developing the mental toughness, self-knowledge and emotional intelligence required to help pilots make it through the high-stakes world of aviation. The transition from cadet pilot to being a skilled pilot is not just one of employment, but of personal development too. Learning to cope with stress, becoming a better communicator, and becoming astute at decision making under pressure are the skills that are just as essential in a cockpit as flying airplanes.

By teaching and reteaching cadets ideas and then asking them to reflect, helps them understand safety as they begin to internalize the concept of safety as more than a set of rules, more than just a habit, making it become a thought pattern. Safety in aviation is not only about checking off lists; it's about developing a mind-set that values caution and collaboration and recognizes that learning is unlikely ever to be finished. Ideas such as the Swiss Cheese Model and identifying dangerous attitudes help cadets begin to analyze safety as something that does not just exist, but is something one needs to pay attention to and be engaged in.

Nontechnical skills, including situational awareness, leadership and stress management, are central to this shift. These competencies serve to demonstrate that the cadets can successfully operate an aircraft under the most demanding conditions, take good decisions, and lead their people under pressure whether in the cockpit or on the

battlefield. By mastering these lessons, cadets become better pilots and more prepared leaders who are ready to handle the challenges of a fast-paced and often dangerous field.

And the transformation is bigger than learning how to take controls and actually fly an airplane. It's about learning how to become someone who is capable of flying an airplane, leading a team, handling stress, communicating effectively and being able to make tough decisions under pressure. Through the excitement of flight and the commitment to every individual, cadets learn to focus as a crew to prepare for takeoff, execute a safe flight and return to the airfield safely.

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THE LANGUAGE OF RESISTANCE: COMMUNICATION AS DEFENSE IN UKRAINE'S WAR EFFORT

David Andrei POP

Coordinator: Col. Prof. **Adrian LESENCIUC,** PhD

"Henri Coandă" Air Force Academy, Brașov, Romania

Abstract: *This paper explores the vital role of persuasive communication as a defensive strategy in the context of the Russian invasion of Ukraine. It highlights how the Ukrainian government, especially President Volodymyr Zelenski and the Armed Forces, mobilized rhetorical tools to shape public morale, influence international support, and counteract enemy narratives. In modern warfare, the ability to control narratives and inspire resistance through language proves to be as critical as military hardware. Through an analysis of speeches, psychological operations, grassroots storytelling, and digital warfare, the paper demonstrates how communication served as both a shield and a sword in Ukraine's war effort.*

Keywords: *Ukraine; resistance; persuasive communication; military leadership; Zelenski; information warfare*

1. INTRODUCTION

Warfare isn't just about missiles and tanks anymore. In today's world, communication represents more than just a support for the individuals implied, it became a primary battlefield. In Ukraine's case, words truly became weapons. As Russia launched its full-scale invasion in February 2022, the Ukrainian response wasn't only military, but also rhetorical. President Volodimir Zelenski's decision to stay in Kyiv, speak to the people daily, and directly address foreign governments marked a new chapter in persuasive leadership.

This paper explores how persuasive communication became central to Ukraine's resistance strategy, not just as a tool of information, but as a true defense mechanism. It will analyze Ukraine's multi-layered communication tactics, including leadership messaging, digital and social media efforts, psychological operations, citizen journalism, and international diplomacy. The aim is to show that in the age of hybrid conflict, winning the narrative is not optional, but vital to survival.

2. STRATEGIC COMMUNICATION AS A WEAPON OF DEFENSE

2.1 Communication in hybrid warfare

The Russia-Ukraine case is a good example of hybrid warfare, being a mix of military aggression, cyber attacks, disinformation campaigns, and psychological operations. In such a situation, traditional lines fade and communication becomes a primary battlefield. Russia deployed massive disinformation operations, including fake news stories about Ukrainian atrocities and manipulated videos designed to obstruct Western support.

Ukraine responded with remarkable speed and cohesion, through it's government, military, and civilians, working in sync to share accurate information. Social media became a virtual front line, where battles for attention, emotion, and credibility were fought minute by minute.

In a hybrid conflict, the goal is not only to destroy infrastructure but to win hearts and minds, to dominate the information environment and shape perception. Ukraine demonstrated that even with an outgunned militarily, a nation can gain significant strategic ground by communicating more effectively. In this sense, communication is not just a support element of hybrid warfare; it is a combat capability in its own right.

2.2 Zelenski's speeches: rhetoric and resilience

What makes Zelenski's communication truly exceptional is not just what he said, but how, when, and to whom. He understood that in a hybrid war, narrative control represents power. Every speech was calibrated not just to inform but to inspire, and each one reinforced the legitimacy and credibility of Ukraine's cause while building moral pressure on international actors.

Zelenski's messaging frequently drew upon the three classical modes of persuasion: ethos, pathos, and logos - as outlined by Aristotle and still used today in leadership communication and strategic influence campaigns:

- Ethos (credibility): Zelenski's choice to remain in Kyiv, often broadcasting from modest surroundings near the frontline, established authenticity. He shared in the physical and emotional risks of his people, earning trust. The military clothing he wore daily became a symbol of unity between citizen and commanders.
- Pathos (emotion): Zelenski's speeches frequently referenced the pain of war: families torn apart, children killed in missile strikes, cities reduced to rubble. These emotionally potent images served to galvanize domestic resistance while also prompting emotional identification abroad. His direct appeals to Western citizens and politicians built a bridge between Ukraine and the global community.
- Logos (logic): Despite the emotional tone, Zelenski remained structured and strategic. He cited facts about military losses and used historical analogies to clarify Ukraine's position. His arguments were not just heartfelt, but also reasoned and policy-driven.

His speeches to foreign parliaments were carefully adapted to their cultural memory. In the UK, he invoked Churchill. In Germany, he spoke of the Berlin Wall. In Israel, he referenced the Holocaust. These references positioned Ukraine's struggle not as a local war, but a global moral test.

Beyond rhetoric, Zelenski's consistency mattered. He spoke daily, never hiding, even as missiles fell. This established a rhythm of reassurance that helped calm panic and establish national unity. Zelenski became not only a leader but a voice for millions.

2.3 The armed forces: social media, psyops, and honesty

While Zelenski inspired from the top, Ukraine's military became a model for tactical communication on the ground. Their social media presence, especially on Twitter and Telegram, was coordinated, timely, and powerful.

Images of destroyed Russian tanks, captured soldiers, and Ukrainian heroes went viral. These were not just for domestic morale, but they also shaped international media coverage and drove foreign policy discussions.

One of the most effective techniques was using humor and defiance. Memes, videos of tractors pulling away Russian vehicles, and footage of grandmothers confronting soldiers became viral symbols of resistance.

A prime example of tactical communication success was the launch of the "I Want to Live" project by the Defence Intelligence of Ukraine.

Through hotlines, websites, and Telegram channels, Russian soldiers were encouraged to surrender by ensuring humane treatment and safety under the Geneva Conventions. According to the Defence Intelligence Directorate (GUR), within the first three months of the hotline's operation in 2022, over 3,500 contacts were made by Russian personnel seeking information on how to defect.

Psychological operations (PSYOPS) also included targeted dissemination of intercepted Russian military communications. For instance, Ukrainian intelligence released audio recordings of demoralized Russian troops complaining about supply shortages and command failures. These releases served dual purposes: to demoralize Russian forces further and to demonstrate Ukraine's intelligence-gathering capabilities.

Transparency remained a cornerstone of Ukraine's strategy. While propaganda was a tool used selectively for morale purposes, as with the "Ghost of Kyiv" myth, overall military communication prioritized factual reporting. Civilian casualties and infrastructure damage were openly acknowledged, reinforcing international credibility.

Visual messaging, too, was powerful. Viral images such as tractors towing abandoned Russian tanks, or footage of Ukrainian grandmothers confronting soldiers, were circulated globally. These served to highlight both civilian resistance and Russian vulnerability, further enhancing psychological resilience at home and abroad.

In sum, Ukraine's armed forces have demonstrated that in modern hybrid warfare, effective social media operations, credible PSYOPS, and an unwavering commitment to honesty form an inseparable triad. By mastering these elements, Ukraine not only maintained its internal cohesion but also gained significant strategic advantages internationally.

2.4 Truth as a strategic asset

In a world where misinformation spreads faster than facts, Ukraine's commitment to honesty became a weapon in itself. Journalists were given wide access to front lines, hospitals, and displaced persons. This openness not only documented the conflict but also built a case for justice.

Citizen journalism emerged as a powerful force. Ordinary Ukrainians recorded footage on their phones, shared reports, and used apps to warn of airstrikes. These grassroots efforts created a massive decentralized information network that was almost impossible to silence.

Internationally, Ukrainian stories were quickly picked up by news agencies, influencers, and politicians. This helped pressure governments to act, to impose sanctions, send weapons, and open borders to refugees. The communication strategy wasn't just defensive; it was proactive, emotionally intelligent, and globally networked.

Ukraine also used its losses to tell the truth. Instead of hiding failures, the government mourned openly, held funerals publicly, and humanized its heroes. This kind of honesty built credibility and strengthened national resolve.

2.5 Communication from below: the people's voice

While state-led communication and military information campaigns played a vital role in Ukraine's defense, perhaps equally powerful was the organic, decentralized flow of messaging from ordinary citizens. Communication from below emerged as a defining force in shaping national and international perception.

From the first days of the invasion, Ukrainian civilians became frontline communicators. Videos of shelling, drone footages of tank convoys, interviews with survivors, and viral social media posts flooded platforms like TikTok, Twitter, and Telegram. Unlike staged media or official reports, these messages were raw, immediate, and highly shareable. Their authenticity resonated globally and helped build a collective identity of resistance.

One of the earliest examples was the video of a Ukrainian woman confronting a Russian soldier and offering him sunflower seeds to place in his pockets, "so flowers will grow when you die here." The video went viral, becoming a symbol of emotional courage, and it was shared not only on social media but on international news broadcasts. Its power lay in its spontaneous, human honesty.

The viral image of a Ukrainian farmer towing away an abandoned Russian armored vehicle with his tractor quickly became a meme and a propaganda tool. While humorous, it symbolized the adaptability and resistance of the Ukrainian people and projected the image of Russian weakness. The video was replayed by Ukrainian Ministry of Defence accounts and picked up by Western media as a morale-boosting visual.

Another powerful grassroots communication effort emerged from digital communities. Volunteer groups like InformNapalm, Euromaidan Press, and individual Telegram influencers played a crucial role in curating and distributing verified content. These informal nodes of communication filled gaps left by official channels and offered regional insights, such as tracking troop movements and geolocating missile strikes.

Moreover, religious leaders, schoolteachers, and local mayors took to livestreams and local forums to encourage calm, organize humanitarian aid, and maintain social cohesion. This created a communication ecosystem where the distinction between military and civilian roles blurred. The entire society became engaged in a form of informational territorial defense.

This grassroots communication served several strategic functions:

- Sustaining internal morale and unity.
- Providing international audiences with a vivid, human picture of the war.
- Disrupting Russian narratives by documenting real-time events.

By empowering its citizens to speak, record, and publish, Ukraine unlocked an unparalleled force multiplier. These voices from below became the moral compass of the war, reminding the world that the conflict was not only geopolitical. Their stories fortified the legitimacy of Ukraine's cause and inspired solidarity beyond borders.

2.6 International responses and feedback

Ukraine's communication strategy during the war not only resonated internally but had a substantial impact on the international stage. The effectiveness of Ukraine's messaging, centered around clarity, consistency, and emotional resonance, shaped public opinion abroad and played a decisive role in foreign policy shifts, military assistance, and international diplomacy.

Following President Zelenski's virtual addresses to various national parliaments, countries responded not only with applause, but with concrete military and economic aid. In the immediate aftermath of his speech to the U.S. Congress on March 16, 2022, the United States passed a $13.6 billion aid package that included lethal aid, humanitarian assistance, and funding for Ukrainian government functions. Zelenski's appeals were also tailored to each national audience, creating a sense of personal relevance that increased political pressure on foreign leaders.

International public opinion also played a crucial role. Videos, images, and messages shared by Ukrainian civilians and soldiers created a sense of urgency and empathy across global audiences. Protests in major cities like Berlin, London, and New York featured slogans taken directly from Ukrainian military messaging.

This external feedback loop was reinforced by Ukraine's responsiveness. Ukrainian ministries translated and disseminated important updates in multiple languages, launched multilingual social media campaigns, and actively engaged with journalists and analysts worldwide. These efforts helped maintain sustained global attention and prevented the issue from fading as the war continued.

Ultimately, international feedback both shaped and was shaped by Ukraine's communication strategy. The narrative of a democratic nation resisting authoritarian aggression proved to be one of the most successful and sustained communication campaigns in modern military history.

3. CONCLUSIONS

The Ukrainian experience during the Russian invasion has redefined the role of communication in military defense. In the context of hybrid warfare, communication proved to be a critical battlefield in itself. Through coordinated strategies involving presidential leadership, armed forces, civilian networks, and digital diplomacy, Ukraine weaponized words, images, and truth to achieve tactical and strategic objectives.

Importantly, this paper has shown that the integration of state-driven and bottom-up communication efforts gave Ukraine an advantage in the war for perception. Whether through spontaneous viral videos or structured messaging campaigns, Ukraine demonstrated that controlling the narrative is as crucial as controlling the battlefield.

In the future, defense institutions worldwide may look to Ukraine not only for its battlefield innovations but for its revolutionary approach to military communication. The Ukrainian case illustrates that information, controlled with courage and clarity, can become an instrument of resistance, resilience, and national survival.

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AN OVERVIEW OF THE UNMANNED GROUND VEHICLES APPLICATION IN EXPLOSIVE ORDNANCE DISPOSAL OPERATIONS

Maria-Teodora CUREA

Coordinator: Lt jg. **Silviu POPA,** PhD student

"Mircea cel Bătrân" Naval Academy, Constanta, Romania

Abstract: *The proliferation of unexploded ordnance (UXO) and the unintended movement of unmanned systems in proximity to active conflict zones have introduced new layers of complexity to national defense and public safety efforts. Romania, situated near the theater of the ongoing Russian-Ukrainian conflict, has experienced increasing exposure to drifting naval mines and uncontrolled UAVs—phenomena that have revealed critical vulnerabilities in existing threat response frameworks. Naval mines, once anchored for tactical defense, have been destabilized and carried by sea currents into Romanian waters, posing direct risks to both maritime infrastructure and civilian populations. Similarly, UAVs that lose communication or control may cross into restricted airspace or crash unpredictably, raising both physical and security-related hazards.*

These developments underscore the need for autonomous intervention systems that can respond swiftly and safely in environments strewn with explosives. This research explores the practical deployment of Unmanned Ground Vehicles (UGVs) in support of Explosive Ordnance Disposal (EOD) missions. Designed for remote operation and equipped with advanced sensing and navigation technologies, UGVs enable safe engagement with hazardous devices, significantly reducing the danger to human operators. By enhancing precision, efficiency, and operator safety, such systems offer a viable path forward in addressing the evolving risks posed by modern conflict spillover.

Keywords*: Unexploded ordnance, national defense, naval mines, remote operation, EOD missions.*

1. INTRODUCTION

Historical and contemporary conflicts reveal a persistent and troubling reality: regions affected by armed engagements, regardless of their scale or duration, often remain affected by the existence of unexploded ordnance (UXO). These remnants of warfare can persist for extended periods after hostilities cease, posing significant and long-term threats to the safety and security of state and non-state actors operating in these areas.

The ongoing conflict in proximity to Romania's borders introduces a significant risk to the country's national security, potentially rendering Romania an unintended "collateral victim" due to the presence of UXO that may reach its territorial waters or coastal regions. Early in the conflict, one of the most immediate threats arose from naval mines dislodged from Ukrainian defensive minefields, deployed initially to neutralize Russian naval vessels.

These mines, carried by maritime currents, not only disrupt maritime navigation but also directly threaten coastal populations, as they may wash ashore.

As the conflict progresses, an additional threat dimension has emerged in Romania's security landscape: the unauthorized penetration of unmanned aerial vehicles (UAVs) into national airspace. Although these incursions are typically unintentional, they present considerable risks, not only due to violations of airspace sovereignty but also because of the potential for UAVs to experience mid-flight malfunctions, leading to the disintegration of the platforms. Such incidents could result in the fall of debris or structural components onto Romanian territory, endangering both public infrastructure and civilian safety.

2. UNMANNED SYSTEMS

2.1 Fundamental concepts of UGVs

An Unmanned Ground Vehicle (UGV) refers to any mechanized apparatus designed to traverse terrestrial surfaces without requiring a human operator onboard to manage its operations. Typically, UGVs are compact, efficient, and user-friendly. They can be operated remotely by a human controller or autonomously, relying on integrated sensors, navigation systems, and computing units. These vehicles are especially valuable in hazardous or complex environments for humans to access, such as areas affected by extreme weather conditions, biological contamination, or other risks that could endanger military personnel. Such technology offers significant operational advantages, particularly in tasks requiring extended work duration. Unlike human operators, UGVs do not suffer from fatigue, physiological needs, or stress, allowing them to perform missions more efficiently and consistently.

2.2 The future potential of Unmanned Systems

The demand for autonomous systems has surged within the defense sector due to their flexibility and efficiency in military operations. Unmanned Ground Vehicles (UGVs) are indispensable for carrying out missions in hazardous environments, adverse weather, and remote regions where human lives are at significant risk. These systems also play a pivotal role in minimizing human casualties during ISR (Intelligence, Surveillance, and Reconnaissance) activities, as they can operate autonomously while being controlled from a secure location. Moreover, advancements in Artificial Intelligence (AI) and Machine Learning (ML) empower UGVs to undertake increasingly sophisticated tasks, such as collaborating with other unmanned systems, autonomously identifying targets, and making real-time decisions. These capabilities significantly enhance their strategic importance on the battlefield.

2.3. Technological progress and its impact on Romania's defense sector

Conflicts occurring in different regions of the world highlight that each military force has specific needs, tailored to the conditions on the ground and the types of threats they face. Therefore, these requirements should form the foundation of discussions on the reorganization and modernization of the defense industry, both at the national level and within international cooperation frameworks. In Romania's case, the defense industry currently relies on a few state-owned production facilities, which are not sufficiently developed to meet demands for modern equipment and technological innovation.

A significant factor contributing to this stagnation is the poor implementation of corporate governance principles in state-owned enterprises. Although these principles were established internationally by the Organisation for Economic Co-operation and Development (OECD) and were transposed into Romanian legislation through Emergency Ordinance no. 109/2011, their practical application has been superficial or even neglected.

The law has not been respected in either its letter or its spirit, allowing inefficient management practices and a lack of transparency to persist in these companies.

Beyond the legislative limitations—many of which are based on a legal framework that is nearly two decades old—another major challenge is the lack of a long-term vision regarding resource allocation. The discontinuity in funding for research and development projects seriously undermines the national defense industry's ability to innovate and adapt. Without consistent and well-planned support, Romania risks remaining dependent on imports and missing out on key opportunities in the face of emerging security threats.

2.4 The role of UGVs in national security assurance

EOD Robots. The EOD robot is designed to replace the human operator in missions involving manipulating and neutralizing explosives or other hazardous elements in a hostile environment. The robot consists of a mobile platform equipped with a mechanical arm, a gripping system, and an integrated sensor system, which plays a crucial role in remote control. This type of equipment can be considered an advanced version of the classic UGV concept.

The Necessity of EOD Robots. The high level of risk associated with the EOD support role is characterized by the fact that military personnel are often in direct contact with harmful and dangerous objects, which may later become lethal. Even though EOD operators are provided with specific equipment for these types of missions, working with explosive materials puts their lives in danger daily.

The primary reason that justifies the necessity of an EOD robot is the minimization of human exposure to the hazards posed by pyrotechnic materials inherent in this field of activity. The use of EOD robots brings the concept of distancing from dangers, which not only ensures the safety of specialists but also provides the opportunity to gather information about the target and the area in which it has been activated.

2.5 The threats posed by drifting mines as a result of the outbreak of the Ukraine war

The naval mine, often referred to as "a poor man's weapon," is a powerful and long-lasting force multiplier used in naval warfare. The small dimensions allow them to hide in plain sight, whether floating on the water's surface, resting at a set depth, or sitting on the seabed. The Black Sea, a semi-enclosed body of water, is particularly vulnerable to waves and currents that can carry these mines along unpredictable paths, creating serious risks for maritime traffic.

A significant incident on September 8, 2022, involved the Romanian naval minesweeper Locotenent Dimitrie Nicolescu (DM-29), which was damaged by a drifting mine. This event raised concerns about national security and reduced public trust in the Romanian Armed Forces' ability to respond to such threats. Fortunately, the damage was minor, and no one was injured. Furthermore, another tragedy occurred when an Estonian cargo ship sank after striking a mine near Odesa.

The danger posed by drifting mines isn't limited to military targets—civilians are also at risk. A tragic example occurred in Odesa, where a man lost his life after encountering a drifting mine while swimming. If the mine hadn’t blown up, the man could have washed ashore and endangered more lives.

These incidents clearly show why Unmanned Ground Vehicles (UGVs) are needed to detect and neutralize such threats. UGVs can help protect civilians, especially in areas far from the frontlines. By using advanced, remotely operated defense systems, we can reduce human risk and increase the effectiveness of operations in dangerous environments.

2.6 The reason behind choosing the project

The motivation behind choosing this project comes from the desire to protect human life from the dangers of mines or other explosive-based devices.

Being aware of the situation at our country's borders and observing that the issue of stranded naval mines is rarely addressed in local media or discussed among military personnel, I recognized the need for a solution. Currently, the unmanned ground vehicles (UGVs) used by security, defense, and public order institutions are costly and require specialized operator training for effective deployment in real-world scenarios. As a result, I designed the concept of a highly efficient UGV, providing an optimal balance between cost and performance.

2.7 The main objective of the project

This project describes the process of building a small-scale Unmanned Ground Vehicle (UGV) designed for EOD missions. Its development required a mobile platform (a chassis onto which the necessary electronic and stability components were integrated), which can be remotely operated via a controller.

The initial chassis configuration underwent several modifications to accommodate the integration of essential system components. Utilizing Autodesk Fusion, custom structural elements were designed to enhance overall stability and were subsequently manufactured through 3D printing, ensuring a secure and reliable platform for the UGV.

A key system element—if not the most crucial—is the Raspberry Pi 5, which handles both sensor input processing and overall operational control. Following the programming process, the Raspberry Pi 5 will be the system's central controller, processing and supervising all incoming data from the sensors.

Another essential and innovative component is the Slamtec RPLIDAR A1 360° system. It provides the UGV with continuous environmental data, enabling it to avoid obstacles and navigate safely without compromising its structural integrity. Moreover, integrating the Raspberry Pi Camera Module 3 NoIR enables reliable remote control by continuously transmitting real-time visual data from the surrounding environment. The remote control system has also been modified to communicate with the chassis and the Raspberry Pi 5 computer.

In contrast to commercially available UGV systems, this project provides a more accessible and cost-effective alternative, with significantly lower production expenses. The system's reduced size offers the advantage of being hard to spot, while the continuous data feed from the field used for remote control is a significant asset in protecting the personnel conducting EOD missions.

3. CONCLUSIONS & ACKNOWLEDGMENT

According to the aspects presented earlier, we can conclude that the technological advancement represented by the use of unmanned ground vehicles (UGVs) in military operations, such as explosive device neutralization, has been driven by the need of political and military leaders to reduce the risks faced by personnel in EOD engineering support units. Historically, human casualties did not significantly affect the psyche of societies and governmental leadership. However, with the emancipation of populations and the expansion of globalization, this aspect has become crucial in the eyes of citizens. Consequently, remotely operated technical means have gained particular importance in military actions, becoming capabilities that keep human sources at a safe distance.

Looking toward the future, the potential of UGVs is immense, both in terms of technological innovation and operational scope.

With the rapid evolution of artificial intelligence and machine learning algorithms, future UGVs could transition from remotely operated systems to semi-autonomous or fully autonomous platforms capable of making real-time decisions in complex and dynamic environments. These advancements would drastically improve response time, accuracy, and adaptability in EOD operations.

Moreover, improvements in sensor technology, including enhanced imaging and detection systems, will allow UGVs to identify threats with unprecedented precision, even in low-visibility or highly cluttered environments.

The integration of UGVs with other autonomous systems, such as aerial drones and robotic logistic platforms, can also establish a collaborative network that significantly enhances battlefield awareness and decision-making. In addition to military use, the versatility of UGVs offers promising applications in humanitarian demining efforts, disaster response, and hazardous material handling, further underlining their role in safeguarding human lives across various domains. Thus, investment in research, development, and training for UGV operations is not only a strategic necessity but a humanitarian imperative for the future.

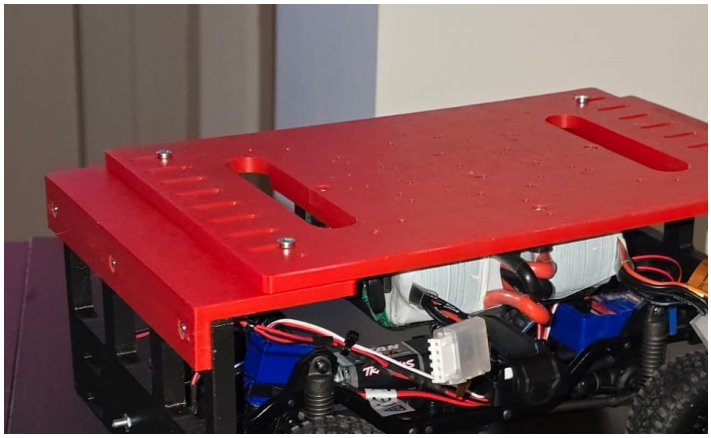

FIG. 1 The use of 3D modeling for system stability

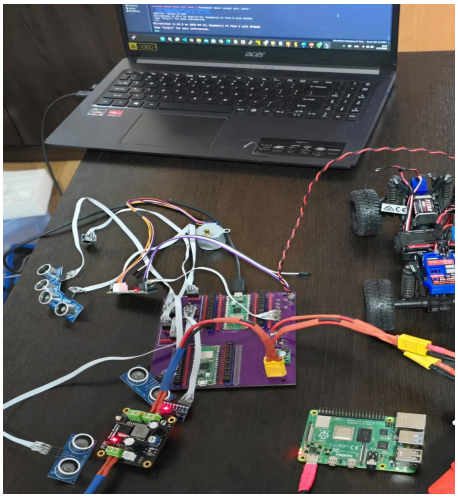

FIG. 2 UGV electrical system setup

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THE IMPACT OF GEOPHYSICAL AND MAGNETIC ANOMALY ZONES ON HF WAVE PROPAGATION AND IONOSPHERIC BEHAVIOR: EXPLORING EARTH-ATMOSPHERE INTERACTIONS

Raul-Nicolae VADUVA, Robert-Ionut MICU

Coordinator: Prof.eng. **Simona MICLĂUȘ,** PhD

Faculty of Military Management, "Nicolae Bălcescu" Land Forces Academy, Sibiu, România

Abstract: *This paper investigates the influence of geophysical and magnetic anomaly zones on the propagation of HF radio waves and the behavior of the ionosphere. Using VOACAP simulations and real-world-inspired scenarios, the study explores how geomagnetic anomalies significantly impact the reliability and quality of radio communications. By examining various antenna configurations and geographic contexts, the research identifies how magnetic anomalies distort HF signals, providing valuable insights for future improvements in predictive models and communication strategies.*

Keywords*: HF propagation, VOACAP, geomagnetic anomalies, ionosphere, radio communication*

1. INTRODUCTION

High-frequency (HF) radio waves, operating within the 3-30 MHz range, have long served as a cornerstone of global communications, especially for long-distance links across continents and oceans. Their ability to reflect off the ionosphere allows them to bypass the limitations of line-of-sight communication. However, the ionosphere is a dynamic medium, heavily influenced by solar activity and geomagnetic conditions.

One of the least understood factors in HF propagation is the effect of geophysical and magnetic anomaly zones, regions where Earth's magnetic field deviates from expected models. These areas introduce significant variability in ionospheric conditions, leading to signal distortion, fading, and even total communication failure.

This paper presents an overview study on how these anomalies affect HF wave behavior, using both theoretical approaches and computer simulations via the VOACAP (Voice of America Coverage Analysis Program) software. The goal is to improve communication reliability in areas prone to geomagnetic instabilities, such as polar and subpolar regions.

2. VOACAP SIMULATION OF THE GENERATED PROPAGATION SCENARIOS

2.1 Methodology and Scenario Design

The analysis conducted in this research is centered on simulation-based modeling using the Voice of America Coverage Analysis Program (VOACAP simulation tool)[3], a well-established software tool for predicting HF radio wave propagation. VOACAP models various atmospheric and solar parameters, simulating signal strength and reliability for diverse frequency bands and antenna configurations.[4]

To evaluate how geomagnetic anomalies influence, the HF signal performance, we defined four experimental scenarios. Each scenario considers different configurations of transmitting and receiving antennas relative to the geomagnetic anomaly zone:

- **Scenario 1**: Both transmitting and receiving antennas are located within a geomagnetic anomaly zone. This configuration assesses the propagation effects when the entire signal path is influenced by disturbed ionospheric conditions.
- **Scenario 2**: Both antennas are situated outside the anomaly, but the signal path intersects it. This scenario reflects a real-world case in which communication is attempted across anomalous regions without directly placing equipment within them.
- **Scenario 3**: The transmitter is outside the anomaly while the receiver is located inside. It investigates signal degradation upon entry into geomagnetically unstable areas.
- **Scenario 4**: The transmitter is placed inside the anomaly while the receiver is outside. This helps us understand how signals are launched from disturbed zones and how this affects initial transmission quality.

Each scenario was carefully designed to provide insights into different signal paths and their interaction with anomalies. Simulations were run using consistent parameters transmission power, frequency, location coordinates, and antenna configuration—to allow fair comparisons. All cases were tested during multiple times of the day to capture diurnal ionospheric changes. The goal was to study how each setup influences critical transmission parameters such as signal-to-noise ratio (SNR), circuit reliability (REL), and received power (SDBW), and to determine which configuration offers the highest resilience to propagation degradation.

2.2 Equipment and Antenna Selection. The antenna configurations used in the simulations were specifically selected to reflect practical deployment scenarios and to capture varying directional and omnidirectional properties. Two primary antenna types were utilized:

- **Yagi antennas**: Known for their high gain and directional precision, Yagi antennas were chosen for their ability to focus energy along a specific axis. This makes them highly suitable for long-distance communication where signal alignment and efficiency are essential, particularly in unstable ionospheric conditions. Their unidirectional radiation pattern allows for better rejection of noise coming from undesired directions, which is vital when operating in or near anomaly zones.
- **Horizontal dipole antennas**: These are widely used in HF propagation due to their omnidirectional behavior in the horizontal plane. Their balanced pattern helps ensure coverage in multiple directions, making them valuable when precise signal paths are not predictable or when coverage needs to be maximized. Dipoles are generally easier to deploy and tune, making them an ideal baseline for performance comparison.

By using both antenna types in various configurations, we could simulate realistic operational setups and compare how directivity affects propagation quality in geomagnetically variable environments. Additionally, antennas were modeled at different heights above ground, allowing the simulation of take-off angles and how they impact skywave efficiency.

2.3 Simulation Outputs

Figure 1 shows the VOACAP interface with the emission and reception points figured on the map.

We used this date of work:Antennas(3-el Yagi 10M(33ft)-transmitter and Dipole 15M(50ft)-receiver)

FIG.1 VOACAP interface with the emission and reception points figured on the map

Figure 2 displays propagation performance for short path (SH-P) scenarios under ideal and anomaly-influenced conditions. The presence of anomalies is indicated by the consistently stable communication, with reliability remaining at 100%. In these cases, REL(Reliability) values remained high when anomalies were avoided, but dropped noticeably when signals intersected with magnetic irregularities[2]. Signal levels in terms of SDBW were visibly higher in non-anomalous configurations, confirming the degrading effects of such zones.

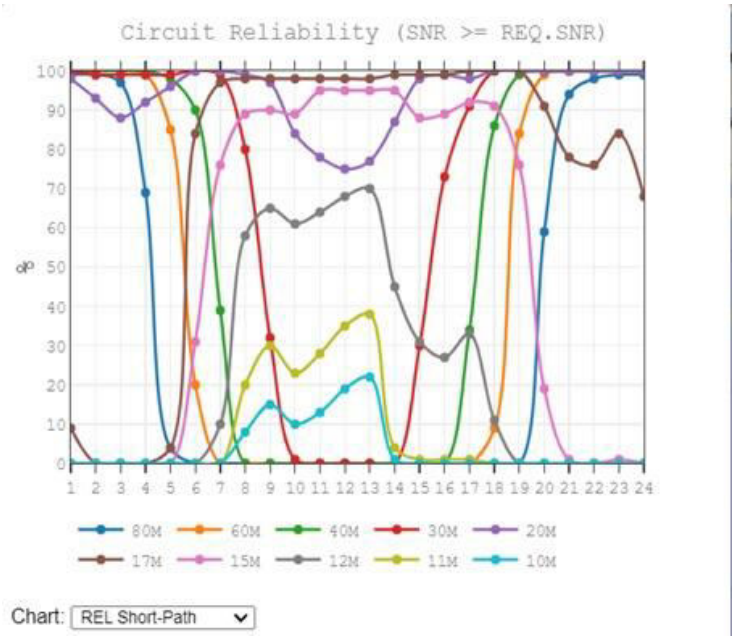

FIG.2 The varation during 24 h

Figure 3 illustrates propagation along long paths (LG-P), demonstrating significant degradation and reduced communication windows due to extended exposure to variable ionospheric layers [2].The charts indicated that for certain hours of the day, no reliable communication was achievable along the long path, regardless of frequency adjustments.[1]

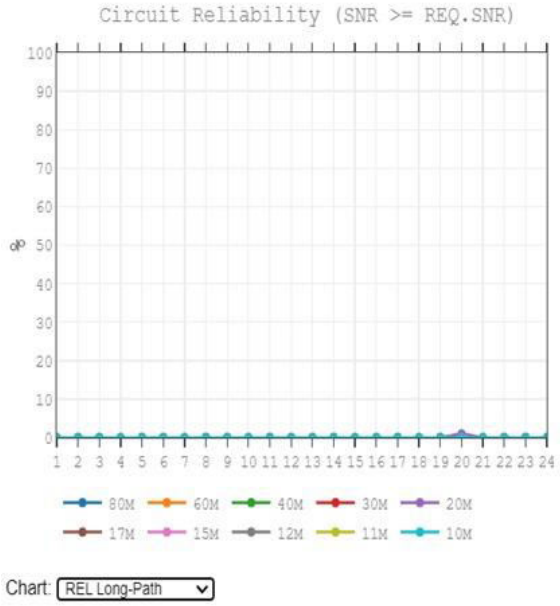

FIG.3 Propagation along long paths (LG-P)

3. RESULTS AND INTERPRETATION

Simulation results showed clear patterns. HF signal reliability deteriorates significantly when signals traverse magnetic anomaly zones. The analysis of REL, SDBW, and SNR values across different configurations revealed the following insights:

- **Scenario 1**, where both antennas were placed within the anomaly, consistently showed the worst performance. The signal path was fully immersed in an unstable ionospheric region, leading to high noise levels, frequent fading, and low received power. This situation mimicked environments where communication infrastructure might be deployed in geophysically volatile zones.
- **Scenario 2** exhibited relatively better results, despite the signal path crossing the anomaly. Because the antennas were positioned in stable zones, the system benefited from more reliable launch and reception conditions. The deterioration was noticeable but less severe, indicating that anchoring at least one end of the communication link in a stable region helps mitigate the effects.
- **Scenarios 3 and 4** showed intermediate degradation, reflecting asymmetric signal behavior when either the transmitter or receiver was affected by geomagnetic instability. The distinction between launching a signal from versus into an anomaly offers tactical implications for real-world antenna placement.

The consistency of the simulation findings with real-world expectations strengthens the model's credibility. Scenario 2's relative success supports the idea of optimizing communication routes by avoiding full immersion in anomalies, even if crossing them is necessary. Additionally, using directional antennas and optimizing frequency selection for the time of day were shown to improve performance in all scenarios.

4. CONCLUSIONS

The research demonstrates the profound impact of geomagnetic anomalies on HF wave propagation, particularly in regions marked by ionospheric instabilities. Simulations show that thoughtful antenna placement can significantly mitigate the adverse effects of magnetic disturbances. VOACAP proved to be an invaluable tool for scenario modeling and planning.

This study emphasizes that proactive route and equipment planning, combined with real-time monitoring of space weather conditions, can greatly enhance communication reliability in geomagnetically sensitive areas.

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DEVELOPMENT OF A SHOCK-REDUCING PARACHUTE PROTOTYPE FOR ENHANCED PILOT SAFETY IN F-16 EJECTION SYSTEMS

Georgiana-Rebeca NEACȘU, Andrada-Daniela NEBUNU

Coordinators: **Ioan-Andrei PETRESCU, George-Alexandru DINCHE, Marius MOGA, Octavian MUNTEANU**

Institute of Military Medicine, Bucharest, Romania

Abstract: *Military aircraft pilots face a tremendous number of challenges due to the rapid evolution of technological innovations and the need to operate at ever-so-high airspeeds. This paper aims to investigate the connection between the injuries sustained by high-performance jet aircraft (HPJA) ejectees and the parachute system incorporated in the airframe of the F-16 Fighting Falcon. Considering the context of a supersonic multirole fighter aircraft, the drag chute of the F-16 ejection seat consists of a critical system component for minimising landing roll distance, particularly on confined landing space or under unfavourable weather conditions. Nevertheless, operational experience has revealed several occurrent issues that are prone to compromise the overall efficiency of this system, jeopardising the pilot's safety. Having assessed the clinical characteristics and the severity of orthopaedic, musculoskeletal and other injuries from military training-related parachute jumping, we intend to provide the conceptual framework for minimising the exposure to life-threatening risks. The prototype will imply a substantial improvement of the classical parachute used nowadays by optimising materials and reconfiguration of the structural aspects. We were inspired by cross-analysing already existing equipment used in modern theatres of operations.*

Keywords: *ejection seat; parachute injury; aviation technology; orthopaedic trauma; parachute prototype.*

1. INTRODUCTION

The multirole F-16 Flying Falcon represents an essential component of aerial technology present in every modern-day army, being employed in a wide range of operational scenarios such as air-air, air-ground combat or reconnaissance (HAF-F16, 2002). Despite high manoeuvrability, emergency situations that imply aircrew's ejection remain an unavoidable aspect of high-performance military aviation, therefore generating significant risks for pilot's medical integrity.

The F-16's automated ejection sequence involves canopy jettison, stabilized seat ejection, parachute deployment and landing (HAF-F16, 2002). This process subjects pilots to extreme biomechanical stress during rapid deceleration and ground impact. In low-altitude ejections with adverse weather, the main parachute's limited energy dissipation often proves inadequate. Such scenarios frequently cause severe trauma including limb fractures and spinal injuries. These limitations highlight critical safety challenges in emergency escape systems.

In operational theatres, protecting pilot's life and physical integrity is a major strategic objective, regarding the aircrew's training costs and the importance of maintaining the

squadron's reaction capability. Therefore, the optimisation of parachute systems constitutes a major operational focus area.

This paper aims to bring forward an applied analysis of the medical and technological challenges implied by post-ejection parachuting from an F-16 aircraft, as well as presenting an adaptive drag parachute prototype – Drag Chute2.0 – a concept for reducing impact forces, thus improving crew survivability and resilience after an incident.

2. EJECTION SYSTEM

F-16 Fighting Falcon uses an ACES II ejection seat, which contains the seat itself, parachute and survival kit. The ACES II is a 3rd generation seat, capable of zero-zero ejection (Coyne). The maximum altitude and airspeeds at which the ACES II seat is able to function is around 600 KEAS or approximatively 1111km/h (Coyne). The maximum acceleration exceeded by the seat is about 12 Gz. The seat normally weighs around 57.6 kg, representing only 1.6% of the total aircraft weight. (Coyne)

The ACES II linked computer presents an input of 3 ejection modes that are automatically selected, by analysing the speed and altitude (HAF-F16, 2002). Mode 1 corresponds to low speed or altitude, highlighting the ability of 0-0 ejection, up to 250kts, mainly because the main parachute is deployed faster, saving time, representing 5.5s in total or 1.8s until the parachute is inflated (HAF-F16, 2002, n.d.; Coyne). Mode 2 lasts for 6.3s in total, the main parachute being fully deployed by 2.8s (HAF-F16, 2002, n.d.; Coyne). Mode 3 is characterised by the delayed deployment until the speed/altitude data is matching either mode 1 or mode 2, frequently observed in high-terrain situations, usually above 15,000ft. In this mode the seat-man separation would entail detaching from the emergency oxygen supply, but also could imply more severe injuries caused by the dynamic stress from the rapid deceleration forces at parachute inflation (HAF-F16, 2002, n.d.; Coyne). Moreover, the time is equivalent to either mode1 or 2. (Coyne)

The ejection sequence: (Lewis, 2002)

- All ejection sequence steps begin only after the canopy jettison is completed
- The shoulder harness is pulled back by the **harness power retraction unit** in order to improve the seat occupant's posture and spinal alignment.
- The ejection gun primary cartridge initiates the upward movement of the seat
- As a result to the first detonation, the gases, which result from the chemical reaction, unlock the plunger from the top latch, resulting in the decoupling of the seat from the airframe.
- The ejection gun secondary cartridges fire, thus maintaining the upward movement set upon the seat by the primary cartridges.
- The recovery sequencing subsystem differentiates data from the four sensors in order to determine the ejection mode (1/2/3)
- The oxygen supply regulator is set to 100% O_2
- Legs and arm restraining straps are fitted and pulled down in order to limit limb flair, and furthermore, decreasing the risks of limb injuries

The seat is ejected at a considerably high speed. In order to prevent further injuries caused by the rapid decrease in speed attributed to the deployment of the main parachute, the drogue parachute system must be deployed first, also stabilising the seat's aerodynamics (Lewis, 2002). The drogue gun bullet is made to extract the parachute from the seat and timed to operate in the exact moment when the seat and its occupant are cleared from all cockpit structures (Lewis, 2002).

After a short time, set by the ejection mode, the locks on the seat harnesses are released, resulting in the man-seat separation (Lewis, 2002). The drogue chute now has the purpose to mediate the full inflation of the main parachute canopy. (Lewis, 2002)

Ejection from a fighter jet aircraft is a last-resort measure taken by the pilot when there is an imminent situation which puts his life in danger, and there is no other alternative to exit the aircraft safely (Lewis, 2002). Some of the most common situations that may require ejection are based on multiple-system or mechanical failures, but also others such as combat-related emergencies, mid-air collisions, loss of control, take-off/landing emergencies, or medical emergencies. (HAF-F16, 2002)

3. INJURIES ASSOCIATED WITH EJECTION

Ejection from high-performance fighter aircraft, such as the F-16, is a life-saving but biomechanically violent process. The accelerations involved, which can exceed 20 Gz in certain circumstances, expose the pilot to a range of trauma, particularly to the spinal column and extremities (Lewis, 2002). A comprehensive understanding of these injuries is imperative to guide the development of advanced parachute systems designed to mitigate shock during ejection and improve pilot survivability and long-term health outcomes (O'Conor, 2020).

Injuries resulting from aircraft ejection can be broadly categorized into three primary groups: skeletal fractures, spinal injuries, and soft tissue trauma, each with distinct etiologies but often interconnected in their presentation (Read, 2000).

Fractures are the most frequently reported injuries following ejection and parachute deployment, accounting for approximately 63.1% of all reported cases in civilian and military studies (Sahin, 2020). The lower extremities are particularly vulnerable, with ankle fractures being the most common, followed by tibial and femoral injuries. These typically result from poor body posture upon parachute landing or the direct impact with uneven terrain (Sahin, 2020).

In military populations, particularly among F-16 pilots, compression fractures of the thoracic and lumbar spine are not uncommon due to the axial loading experienced during seat ejection (Lewis, 2002). Cervical spine fractures, although less frequent, pose a greater threat due to their proximity to vital neurological structures (Lewis, 2002).

Spinal trauma encompasses injuries such as vertebral subluxations, disc herniations, facet joint damage, and cord contusions. These injuries result from abrupt axial loads and rotational forces during ejection (O'Conor, 2020). Notably, the C1-C2 region is particularly susceptible, with atlantoaxial dislocations having been reported in pilots who underwent command ejection without pre-warning (Lewis, 2002).

Disc protrusions in the cervical region (e.g., C5/C6) have also been documented, often leading to temporary or permanent neurological deficits. MRI imaging frequently reveals cord edema and increased T2-weighted signal intensity in symptomatic pilots (Lewis, 2002).

Soft tissue injuries account for about 37% of reported trauma and include ligamentous sprains, muscle contusions, and lacerations. These injuries may result from direct impact with the aircraft canopy, the parachute rigging lines, or flailing of limbs during high-speed descent (Read, 2000).

Moreover, helmet-related injuries—especially in pilots wearing heavy head-supported mass (HSM) devices such as night vision goggles—are commonly linked to whiplash-like cervical trauma and jaw fractures during canopy blast or airblast exposure (O'Conor, 2020).

A multitude of variables determine the severity of injuries sustained during ejection. These factors can be divided into mechanical, physiological, and operational categories (O'Conor, 2020).

Mechanical Factors

Ejection Seat Design and Timing: Modern ejection seats employ multistage propulsion to reduce spinal stress; however, misalignment of the spine at the moment of ejection (e.g., if the pilot is slouched or improperly braced) can result in angular acceleration injuries and vertebral compression (Coyne, n.d.; Payne, 1974).

Parachute Opening Shock: Rapid deceleration from canopy deployment transmits sudden forces through the risers into the cervical spine, especially if body position is suboptimal (Hogue, 2012).

Physiological Factors

Age and Physical Conditioning: Older pilots or those with preexisting degenerative spinal changes are more prone to vertebral and discal injury. Muscle strength and flexibility—particularly in the neck, back, and core—are critical to absorbing and dissipating impact forces (O'Conor, 2020).

Gender: Statistical evidence suggests a higher incidence of injury in male pilots, likely due to the overrepresentation in combat aviation roles. However, biomechanical studies indicate that female pilots may experience different force distributions due to variations in bone density and body mass (O'Conor, 2020).

Operational Factors

Pilot Posture: Poor posture during ejection or landing (e.g., legs apart, arms flailing) increases risk of fractures, dislocations, and sprains (Payne, 1974).

Environmental Conditions: Surface wind velocity, terrain roughness, and landing obstacles (trees, buildings, utility wires) significantly elevate the likelihood of lower limb and pelvic injuries (Sahin, 2020).

Flight Profile and Aircraft Speed: Higher altitude and velocity at the time of ejection correlate with increased injury severity due to greater kinetic energy at the point of parachute deployment (Hogue, 2012).

Although detailed epidemiological studies specific to F-16 pilots are limited due to the sensitive nature of military data, several documented cases and broader military analyses provide insight into injury prevalence and distribution (Read, 2000).

Radiographic evidence of spinal injury is observed in 30–70% of pilots following ejection. A review of RAF ejection events noted an average annual ejection rate of 0.17 per 10,000 flight hours (Read, 2000). Among parachuting-related injuries (based on 110,000 civilian jumps), 83.8% of injuries occurred during landing, with only 9.3% linked to parachute deployment malfunctions (Sahin, 2020). The male-to-female injury ratio is approximately 3.74:1, and the mean age of affected individuals is 29.3 years (Sahin, 2020). These statistics underscore the fact that most injuries are not due to mechanical failure but are instead linked to human factors and body biomechanics (O'Conor, 2020).

Several documented clinical cases serve to illustrate the complex nature of ejection-related injuries (Lewis, 2002):

Case 1 – Atlantoaxial Dislocation

A 35-year-old navigator experienced atlantoaxial dislocation (C1-C2) after command ejection. Initial symptoms included reduced Glasgow Coma Score and unilateral limb weakness. Imaging confirmed transverse ligament avulsion. Surgical fusion of C1/C2 was required. Although the patient regained motor function, persistent brachial plexus weakness precluded a return to flight.

Case 2 – Cervical Disc Herniation

A pilot presented with bilateral upper limb paraesthesia after ejection. MRI showed central disc protrusion at C5/C6 with spinal cord contusion. He underwent successful anterior cervical discectomy and interbody fusion, returning to flight duties within six months.

Case 3 – Thoracic Compression Fracture

Following ejection, a 30-year-old pilot reported lower back pain. Imaging revealed anterior C6 compression with no neurological compromise. Conservative management (immobilization and physiotherapy) led to full recovery and return to service.

Case 4 – Minor Thoracic Fracture

A navigator reported localized thoracic pain with minor vertebral height loss at T9. Bone scan confirmed microtrauma. Physical therapy restored full function.

4. LIMITATIONS FOR IN-USE PARACHUTES

Ejecting from a high-performance jet aircraft, such as an F-16 Fighting Falcon, involves an extremely rapid and hazardous sequence of events in which every component of the recovery system is a direct contributor to the survival of the pilot (Ellistgaard, 1987). One of the most critical elements of this system is the parachute, in its standard form, it presents a series of important technical limitations. These limitations become noticeable especially in extreme flying conditions -supersonic speed, low altitude or upper-atmospheric rarefaction conditions - where parachute performance can decisively influence the result of ejecting (HAF-F16, 2002).

One of the principal limitations of standard parachutes is the necessary time for fully inflating. In the scenario of high-speed ejection, for example, a speed above 700km/h, approximatively 0.57 Mach or 378 knots, the complete opening of the parachute is obtained in 2-3 seconds (HAF-F16, 2002). This time period, although seemingly short, is critical, especially in Mode 1 ejections, reducing significantly the life-saving opportunities (Houge et. al, 2012).

Sequential opening of the parachute, predominantly utilised for sudden deceleration, could potentially reduce the risk of collapse within the parachute, however, it does not entirely eliminate the risk of delayed inflation (Houge et. al, 2012).

In the moment of canopy deployment, the decelerating forces exerted on the human body are extreme and sudden, reaching a peak value of 10-15 G, are transmitted to the body via the harness assembly to the shoulders, hips and vertebral column (Lewis, 2002). Due to this force transfer, the aircrew is exposed to a high risk of traumatic loading. Most frequent lesions correlated to this phase of the ejection are: vertebral fractures, disk compressions, glenohumeral dislocation or lower limb injuries due to limb flare. (Pillay, 2000)

State-of-the-art parachute designs do not incorporate active shock attenuation systems capable of substantially reducing these biomechanical impact forces (Houge et. al, 2012). Existent designs are mainly based on harness geometry and sequential opening; however, these models could not completely eradicate the risks (Houge et. al, 2012).

Another major limitation of the standard parachute is their inability to autonomously adjust to major fluctuations in flight parameters and operator/equipment physical properties (HAF-F16, 2002). In the case of an F-16 ejection, these variables could also include: aircraft speed in the moment of the incident, the altitude where the chair/airframe separation takes place and the total mass of the pilot-ACES II assembly (HAF-F16, 2002, n.d.; Coyne).

High velocity risk parachute deployment failure and material damage due to aerodynamic forces. At high altitudes, low air density and extreme cold cam delay inflation, causing unstable descent. Traditional systems also lack real-time mass adaptation, leading to dangerous impact forces, above 8 G, and descend speeds of 4-6 m/s. (Houge et. al, 2012)

5. DESIGN AND DEVELOPMENT OF A SHOCK-REDUCING PARACHUTE PROTOTYPE FOR F-16 EJECTION SYSTEMS

Designing a shock-absorbing parachute system for the F-16 requires balancing aircraft engineering limits with human physiology tolerances, as ejections can occur at speeds over Mach 1.

The new parachute system must fulfil the following core requirements:
-Capable of deployment within 2 seconds under standard operating conditions.
-Must reduce opening shock forces by at least 30% compared to conventional canopies.
-Ensure vertical descent speed remains below 4.5 m/s at sea level.
-Integrate with the ACES II ejection seat system and avionics without requiring aircraft modification.
-Maintain structural integrity in extreme temperature ranges from -60°C to +50°C.
-Offer reliability in excess of 99.9% across a full envelope of operational scenarios.

Material selection plays a pivotal role in the effectiveness of a parachute system, particularly when the objectives include both strength and shock absorption. Canopy fabrics must resist tearing under dynamic loading while remaining lightweight and flame resistant. Advanced composite textiles such as Kevlar-reinforced nylon was selected for their tensile strength and flame retardant properties. Suspension lines made of Spectra fibre offer high modulus of elasticity with minimal stretch, reducing oscillations during descent.

For the risers and harnesses, Vectran was selected due to its high cut-resistance and resistance to moisture degradation. A cushioned load-distribution system using closed-cell foam was integrated into the harness structure to minimize localized pressure and spinal impact. Nomex was used for deployment bags due to its flame retardance and resilience under canopy extraction loads. All materials were subjected to accelerated aging tests and dynamic stress modelling under simulated ejection scenarios.

A barometric-initiated deployment sequence ensures that the main canopy does not deploy until safe altitude and velocity parameters are met. In addition, a G-force sensor was integrated to abort main canopy deployment in the case of tumbling or unstable trajectories, reducing entanglement risk. All components were designed using CAD modelling and validated through wind tunnel tests and air-drop campaigns.

Prototypes were developed at 1:1 and 1:4 scale using full-spec materials. These were tested in suborbital drop simulations, vertical wind tunnels, and HALO-style descent environments. Anthropomorphic test dummies (ATDs) equipped with accelerometers and gyroscopes recorded biomechanical data. These tests demonstrated an average reduction of opening shock from 18.2 G to 11.4 G, and descent speeds dropped from 6.1 to 4.2 m/s.

Additional sensor feedback highlighted a 38% reduction in neck torque during deployment, a critical metric in reducing cervical spine injury. Flight simulations using computational fluid dynamics (CFD) also demonstrated canopy stability in crosswind conditions up to 18 knots.

The enhanced parachute design has direct implications for mission readiness and survivability. Faster recovery from ejection-related injuries means reduced time off-duty for skilled pilots and lower replacement costs.

The increased confidence in survival mechanisms may also psychologically enhance combat effectiveness. Furthermore, the system is designed to be cross-compatible with other NATO-standard aircraft including the F/A-18, Typhoon, and Mirage 2000, offering broad applicability. The reduction in post-ejection trauma contributes to operational sustainability during high-risk deployments.

Future versions of the parachute will integrate smart fabrics that can dynamically adjust porosity based on barometric readings. Embedded sensor arrays will allow real-time telemetry and post-deployment diagnostics. Further biomechanical studies are proposed in collaboration with NATO aerospace medicine units to refine the kinematic profile during descent. Simulated low-gravity and high-altitude testing, combined with machine learning algorithms, may offer real-time adjustment of the deployment profile based on the pilot's physical condition, as measured via integrated biomedical sensors in the G-suit and helmet. These developments will further solidify the prototype's role in next-generation aircrew survival systems.

6. CONCLUSIONS

This study has investigated the biomechanical risks associated with ejection from the F-16 Flying Falcon aircraft and explored innovative technological resolutions to enhance pilot safety. The analysis of frequent injuries, highlighted the vulnerabilities of current parachute systems. In this context, Drag Chute 2.0 was proposed – an intelligent braking parachute prototype capable of mitigating impact shock through an advanced technological ensemble: lightweight yet durable materials, adaptive aerodynamical architecture and real-time digital control. The solution offers concrete prospects for operational implementation, supported by modular design and automated maintenance. Through this contribution, the study aligns with contemporary efforts to modernize rescue equipment, reinforcing the strategic objective of protecting flight personnel in tactical and extreme conditions.

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ENHANCING FL LEARNING THROUGH DIGITAL SIMULATION AND GAMIFICATION: A CASE STUDY OF *WAR THUNDER*

Rares FASIE

Coordinator: Lect **Ramona HARSAN**, PhD

"Henri Coandă" Air Force Academy, Braşov, Romania

Abstract: *In recent decades, video game simulators have demonstrated significant potential in military training, and* War Thunder*, a popular video game simulating air, land, and naval combat from World War II up to the modern period, could be used to enhance soldier training. Therefore, the aim of this project is to showcase the potential exploitation of the* War Thunder *videogame to create a foreign language (FL) training environment for cadets, as the game offers complex simulations of military vehicles and combat strategies. Games like* War Thunder *can be used as gamification techniques in higher education programs, and could be further used in military education as part of a broader training program that includes controlled combat simulations.*

Keywords *(max.5): War Thunder, virtual combat simulations, English as a Foreign Language (EFL), digital gamification.*

1. INTRODUCTION

As the pace of technological progress has accelerated, military training has had to adapt to the new demands of contemporary warfare. Technological innovations such as virtual simulations, augmented reality, artificial intelligence and the use of drones have profoundly reshaped the nature of armed confrontation, forcing armies to rethink their training strategies. In this context, the training of soldiers can no longer remain anchored exclusively in classical physical and tactical training, but must be expanded to include technical and digital skills. These are essential for the effective operation of state-of-the-art equipment and rapid adaptation to an increasingly sophisticated and unpredictable theater of operations. Recent technological developments have profoundly redefined the way military strategies and tactics are conceived. Armed conflicts no longer involve exclusively the deployment of troops and the use of conventional warfare, but increasingly involve actions such as cyber-attacks, drone warfare, cyber warfare and even confrontations in outer space. In the face of these new realities, the training of military personnel must follow an innovative path, tailored to provide them with the skills needed to manage increasingly diverse and sophisticated threats. Contemporary warfare also requires effective and rapid coordination between the various components of the armed forces - from infantry troops and armored units to air and naval forces. In this context, military training must provide soldiers not only with individual skills, but also with opportunities to actively collaborate with other operational structures. The development of interoperational skills thus becomes essential for the success of complex missions in modern combat theatres.

In this general context, foreign language (FL) learning must be considered as an important part of interoperational skills, and technological progress has started to visibly affect teaching strategies.

As one of the newest and most notable trends in FL teaching, "gamification" (Cheong *et al.*, 2014; De La Cruz *et al.*, 2023) and "digital gamification" (Deterding *et al.*, 2011) have started to emerge as a point of interest for progressive, learner-focused teaching strategies (Zakaria & Mahat, 2024). Thus, we must consider the potential of gaming as a resource in teaching specific topic-oriented FL vocabulary, such as the cases where English for specific purposes/ESP (Hutchinson, 1987) is taught to undergraduate-level military cadets. Core modern teaching techniques such as word part analysis (Nation, 2013) and the keyword technique (Nation, 2013; Boers, 2012), or the more general organization of learning based on topic-related vocabulary input (Chung & Nation, 2003) can all be easily applied to digitally gamified content, for word-collection or as a content "reactivation" strategy (Cross, 1992: 180-190). In what follows, an illustration of *War Thunder* as a useful context for CBI, i.e., content-based instruction (Davies, 2003).

War Thunder is an air, land and naval combat simulation video game created and published by Gaijin Entertainment. Launched in 2012, the game is available on various platforms such as Microsoft Windows, macOS, Linux, PlayStation 4, Xbox One, PlayStation 5 and Xbox Series X/S. In War Thunder, players can control a wide range of combat vehicles including airplanes, tanks, warships and helicopters, covering various historical periods from World War I to modern conflicts. The game offers several modes such as Arcade, Realistic and Simulator, each with a different level of complexity and realism. Over time, War Thunder has received numerous updates and expansions, bringing new vehicles, maps and game modes. The game is appreciated for its realism and active community of players.

2. ANALYSIS: WAR THUNDER AS AN ASSET IN TEACHING GENERAL MILITARY TERMINOLOGY

2.1. *War thunder* as a virtual battlefield. Virtual combat simulations are advanced digital tools that allow users to train in a controlled environment that accurately reproduces the conditions of a real military conflict. These simulated environments are developed through specialized software and video games, and are capable of integrating a wide range of tactical scenarios - from land and air operations to naval exercises or large-scale confrontations. Such technologies contribute significantly to the practical training of the military in safe but realistic conditions. Virtual combat simulations generally provide an accurate rendering of the various military equipment, vehicles, weapon systems and tactical procedures used in the field. Participants can explore both the difficulties encountered directly on the battlefield and the complexity of the strategic decisions required during a confrontation. These digital scenarios are interactive and often include real-time feedback, allowing users to learn from mistakes and quickly adjust their behavior or decisions as the simulated situation evolves.

Air combat simulations are specially designed to accurately reproduce the specific conditions of air-to-air combat. They give pilots the opportunity to train in realistic scenarios involving fighters, bombers and various tactical missions. An example of this is the War Thunder platform, which integrates detailed air combat elements, including defense and attack missions in combined contexts, also involving actions on water.

Land simulations focus on reproducing ground combat conditions using tanks, armored vehicles and infantry troops. These scenarios allow the military to practice unit coordination, field tactics and real-time decision-making in a secure and predictable environment.

Naval simulations address the maritime dimension of military confrontations, giving participants the opportunity to command warships and take part in complex battles at sea.

These exercises include both offensive strategies and defensive tactics, adapted to the particularities of the aquatic environment and the specifics of naval equipment.

Combined combat simulations bring together all three dimensions - air, land and sea - providing an integrated framework for training involving cooperation between the different branches of the military. They are particularly useful in developing the inter-force coordination capability essential in modern military operations.

Virtual simulations have a wide application in military training, with many advantages over traditional training methods. They are used by militaries around the world to provide comprehensive and diversified training, preparing soldiers to deal with a wide range of scenarios and challenges. Virtual simulations have become essential tools in military training, due to their wide applicability and multiple advantages over traditional methods. They are being adopted globally by armed forces as they allow for varied and complex training, preparing soldiers to react effectively to a variety of operational situations and challenges.

Performance evaluation is a major benefit of virtual simulations, as they offer the possibility of constant monitoring of results at both individual and team level. Real-time feedback allows real-time analysis of decisions and actions taken during exercises, directly contributing to the refinement of tactical skills and the identification of vulnerabilities requiring improvement. Reducing costs and increasing safety are other key benefits of these technologies. Unlike conventional training, simulations do not involve large expenditures on physical resources such as vehicles, ammunition or complex equipment. At the same time, conducting exercises in a virtual environment greatly reduces the risks to participants, eliminating the dangers inherent in field training. Flexibility and accessibility are other notable strengths. Simulations can be used in a variety of locations without requiring special facilities or expensive infrastructure. This feature makes training much more adaptable and accessible to a wide range of military units, helping to streamline the training process.

At first glance, War Thunder may seem like just another video game. But when we look closer, we realize it could be much more: a virtual battlefield, where real-world military terminology, tactics, and decision-making are put into practice in a dynamic, high-pressure environment.

In War Thunder, players don’t just “play”—they learn to think like pilots, tank commanders, and air defense officers.

2.2 Topic-related vocabulary. The game integrates authentic military terminology, which could easily be organized in topic-related terminological sub-classes. In what follows, we provide an illustrated example of such basic organization for *War Thunder*.

a) Category 1, Pilot and ATC Talk: radiotelephony and brevity codes.Examples selected based on the game are: "Fox One"-Launch of a semi-active radar-guided missile (e.g. AIM-7 Sparrow); "Fox Two"-Launch of an infrared-guided missile (e.g. AIM-9 Sidewinder); "Fox Three"-Launch of an active radar-guided missile (e.g. AIM-120 AMRAAM); "Splash"-Target has been destroyed; "Bingo Fuel"-Minimum fuel level to safely return to base; "RTB"- (Return to Base)Returning to the airfield/base; "Tally"-Enemy aircraft spotted; "No Joy"-Can't see the enemy; "Winchester"-Out of ammo or ordnance; "Jink"-Evasive maneuver to avoid missiles or gunfire; "Check Six"-Watch your rear for threats; "Guns, Guns, Guns"- Firing guns at the target, and so on.

b) Category 2, Ground Forces & Combined Arms Terms. A few illustrations are: Term-Meaning; MBT-Main Battle Tank; IFV-Infantry Fighting Vehicle; APFSDS-Armor-Piercing Fin-Stabilized Discarding Sabot (a kinetic tank round); HEAT-High-Explosive Anti-Tank (explosive round that melts through armor); Overpressure-Killing a vehicle crew via shockwave (used IRL too);

Hull Down-A tank position where only the turret is exposed; Defilade-Protected position that hides you from enemy fire; Line of Sight (LOS)-Can you see/shoot the enemy directly; Splash Damage-Area damage from artillery or bombs; Soft Target-Lightly armored or unarmored target (infantry, trucks); Hard Kill-Physical destruction of an enemy platform; Thermals / FLIR-Forward Looking Infrared – used to detect heat signatures etc.

c) Air Surveillance, Electronic Warfare and Air Defense. This category would include terms such as: SAM-Surface-to-Air Missile; AAA-Anti-Aircraft Artillery; RWR-Radar Warning Receiver (detects radar locks); ECM-Electronic Countermeasures (jamming enemy radar/missiles); Radar Lock-When radar locks onto a target for tracking/firing; BOLO-Be On the Lookout (used for searching enemy activity); Splash Zone-Area where a bomb or shell is expected to hit; Kill Zone-Area of expected enemy destruction during ambush; Target Painted-Target is designated or marked (often for laser guidance).

These terms can be found in the game, both specified in equipment and technique as well as spoken by the players.As example:Vehicle Classifications (the tech tree where vehicles are grouped by type,vehicle description cards that explain their battlefield role, spawn menus during battle, where roles like tank destroyer or anti-air are shown); Ammunition Types (The loadout screen when you choose what ammo to bring into battle, the modification menu, where you unlock and equip new ammo types, the in-battle interface when selecting shells at a resupply point); Optics & Targeting Systems (The gunner or commander view HUD during gameplay (rangefinders, thermal imaging, etc., the modifications menu, as unlockable equipment (like stabilizers or laser rangefinders), keybind settings, where you assign controls to optics functions); Combat Doctrine Concepts (Not directly labeled, but emerge through gameplay mechanics, Reinforced through tutorials and player communicatio(e.g., strategy tips or voice commands),Recognizable in how tactics must be applied to succeed (like positioning, flanking, cover use); Aircraft & Missile Systems(The aircraft loadout menu, where each weapon is labeled with its guidance type and role, The cockpit or HUD, showing radar modes, missile types, and targeting info,stat cards and tooltips, which explain missile behavior and tracking capabilities); Naval Classifications & Systems (The naval tech tree, grouping ships by type (destroyer, cruiser, etc.), The battle spawn screen, where ship classes are listed,the loadout and stat interface, showing shell types and turret setups).Furthermore, such techniques as vocabulary collection, word part analysis, the keyword technique could be applied starting from the game, from re-occurring terms, prefixes, suffixes and abbreviations, in a learning environment that provides a lifelike virtual simulation and renders the teaching/learning environment much more attractive for EFL learners.

2.3 Benefits of Virtual Simulations in Training. Realism in safe conditions: One of the key advantages of virtual simulations is their ability to recreate highly realistic combat environments without exposing participants to real dangers. These simulations can include variable factors such as weather conditions, geographical features or the scale of the conflict, thus providing a credible framework for training in complex scenarios similar to those encountered in modern conflicts.

Training tailored to specific needs: Another major benefit is the flexibility of these simulations, which can be customized according to the objectives and requirements of each unit. Exercises can be geared, for example, towards specialized combat techniques, resource management during missions or developing the ability to collaborate between different military structures.

Enhance coordination and collaboration: Many virtual simulations emphasize teamwork, giving participants the opportunity to practice communication and coordination skills in a dynamic operational environment. These skills are essential in combined combat scenarios, where the success of a mission depends to a large extent on effective synchronization and cooperation between different branches of the armed forces.

Simulators such as *War Thunder* can be a potentially transformational tool in contemporary military training, provided they are used in a conscious, integrated and critically discerning way. They can effectively support the decision-making, tactical and technical skills development of military personnel, while providing a safe, cost-effective and interdisciplinary framework for training. It is essential, however, that the use of these technologies is complemented by field experience, empathy and emotional intelligence, as well as sound psychological resilience - fundamental qualities for survival and effectiveness in the real context of armed conflict.

2.4. A matter of attachment and familiarity. Many of our cadets grew up on *War Thunder*.

They enter our schools with a surprising familiarity with concepts like radar cones and missile guidance, thermal detection ranges, combined arms tactics and the importance of crew coordination under fire.So, instead of ignoring this foundation, we should build on it. *War Thunder* can act as a gateway to more formalized simulator training like DCS World, VBS, or real-time combat simulations used by NATO.

2.5. Examples of worldwide implementation: *War Thunder* in military education and training. Although training the military through video games has its challenges, such developments are happening and have happened worldwide. We can find such examples in the USA, Ukraine and Argentina.

a) The United States used *War Thunder* as an alternative training solution during the pandemic

In 2020, with the restrictions imposed by the COVID-19 pandemic, U.S. Army units were forced to find alternative solutions to maintain operational readiness. Thus, tank crews from D Troop, 6th Squadron, 9th Cavalry Regiment, part of the 1st Cavalry Division, began using *War Thunder* as a combat simulator. Using computers and Internet connections, the soldiers conducted virtual sessions in which they practiced tank crew roles, maneuver tactics and combat communications. The game allowed them to train safely, conduct briefings, simulate missions and analyze post-combat actions. This method was officially recognized by the unit as beneficial for maintaining tactical discipline and familiarization with essential concepts of combined combat.(*Task & Purpose, Business Insider, 2020)*

b) Ukraine - Experience from the game applied in real combat

In January 2024, a real incident on Ukraine's eastern front caught the attention of the international media. A Ukrainian serviceman, identified as Serhii, an M2 Bradley armored vehicle operator with the 47th Mechanized Brigade, managed to destroy a Russian T-90M tank, one of the most modern tanks in the Russian forces. Serhii later said his experience in military video games, especially *War Thunder*, helped him significantly. In the game, he learned the armor characteristics and weaknesses of the T-90M, information that allowed him to execute a precise strike in real combat. This example shows how digital simulation can develop an applied understanding of military equipment and influence effectiveness in real missions.(Business Insider, January 2024)

c) Argentina - Integrating *War Thunder* into the military curriculum

Starting in 2022, the National Military College of Argentina began using *War Thunder* in the training of cadets.

The institution adopted the game as an educational simulator, especially for tactical training and familiarization with modern military platforms. Cadets were organized into teams, carrying out virtual missions simulating real-life battles with vehicles and aircraft of different eras, having to communicate effectively, apply combat doctrine and make decisions under pressure. As an accessible platform, *War Thunder* provided students with an opportunity to interactively test their classroom knowledge, contributing to their understanding of the principles of combined combat, coordination and the use of diverse weaponry.(Wikipedia – War Thunder > Military Training Tool)

These examples provide an encouraging perspective on the feasibility of the efficient gamification of FL teaching in military academies and on how *War Thunder* could be used as content for foreign language CBI.

3. CONCLUSIONS

War Thunder goes beyond the status of a simple video game, functioning as a realistic combined combat simulator that provides an ideal interactive framework for learning military tactics, operational procedures and terminology specific to air, land and naval forces. Through the use of authentic terminology, the simulator contributes significantly to familiarizing trainees with NATO communication protocols and language specific to real operations, preparing them mentally for the complexity of combat situations.The dynamic scenarios generated by War Thunder expose users to decision-making under pressure, thus developing essential cognitive skills such as rapid reaction, prioritization of objectives, team coordination and adaptability in an operational context. These skills are fundamental in preparing a military fit for today's demands. In addition, the platform's accessibility, low cost and scalability make War Thunder a valuable educational tool that can be easily integrated into the curricula of both military institutions and extra-curricular activities designed to train future military personnel.

Case studies conducted in the United States, Argentina and Ukraine show that the experience gained through the use of simulators such as War Thunder can have a positive impact on actual performance in the context of military operations. The integration of this type of technology into the training programs of military institutions helps to bridge the gap between theoretical and practical training, providing concrete support for the transition to real combat conditions. At the same time, War Thunder creates a safe environment for practice, where mistakes become opportunities for learning and self-assessment. The platform encourages rigorous adherence to combat procedures and the development of a culture of collaboration between the different components of the armed forces, which is essential in a modern, integrated operational environment.

So, by adopting the concept of gamification and introducing hyper-realistic video games such as War Thunder in their training, military students develop in addition to strategic thinking and rapid action in difficult situations, a vast international military vocabulary with terms, expressions and codes.This is beneficial because it improves their communication and understanding of English which is essential in a military career, increases interoperability between weapons and especially external collaboration with troops and technology of allied countries.

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MANUFACTURING A HEROINE: MEDIA, MYTH, AND THE EXPLOITATION OF JESSICA LYNCH IN IRAQ WAR NARRATIVES

Ella-Mateea NEDELCU

Coordinator: Lect **Ramona HĂRȘAN**, PhD

"Henri Coandă" Air Force Academy, Brașov, Brașov

Abstract: *This paper examines the construction and consequences of the fabricated hero narrative surrounding Jessica Lynch, a U.S. soldier captured during the 2003 Iraq War. Through a critical analysis of media coverage, government communications, and cultural artifacts, the study reveals how Lynch's traumatic experience was distorted into a propagandistic tool to justify military intervention and rally public support. By contrasting her portrayal with the erasure of marginalized soldiers—such as Lori Piestewa, a Native American casualty, and Shoshana Johnson, a Black POW—the research highlights systemic racial biases in wartime storytelling. The analysis further critiques the 2003 film Saving Jessica Lynch as a case study in "militainment," demonstrating how entertainment media sanitizes conflict to align with nationalist agendas. Lynch's eventual rejection of the myth, through congressional testimony and advocacy, underscores the ethical imperative to prioritize truth over sensationalism. Her journey—from exploited symbol to advocate for veterans—exposes the psychological and societal costs of imposed celebrity, urging a reevaluation of how trauma and identity are commodified in service of political narratives.*

Keywords*: media manipulation; wartime propaganda; racial bias; militainment; veteran advocacy*

1. INTRODUCTION

Jessica Lynch, a young soldier from West Virginia, became famous overnight in 2003 after her rescue from Iraq. But her story was not what it seemed. Media and military leaders falsely claimed she fought bravely against enemy forces, turning her into a "hero" to boost support for the war. In reality, her injuries came from a vehicle crash—not combat—and her rescue was staged for TV cameras. As Amy Wells notes in *Between Myth and Memoir: American Female Soldiers' Writings of the Iraq and Afghanistan Wars*, "the image of American female soldiers is often positioned somewhere between traditional myths of femininity/masculinity and the reality of soldiers' experiences as detailed in their memoirs" (Wells, 2022: 1). Lynch's case exemplifies this tension between myth and reality.

This paper reveals how Lynch's trauma was twisted into propaganda. It contrasts her fame with the ignored stories of Lori Piestewa, a Native American soldier killed in the same attack, and Shoshana Johnson, a Black POW. Their erasure shows how race and gender shape who gets called a "hero." By examining these narratives—and Lynch's own efforts to reclaim her story—this study invites reflection on the complexities of wartime representation. It asks: What do these stories reveal about how societies remember conflict, honour service, and confront the gap between myth and reality?

2. FROM SOLDIER TO SYMBOL: HOW THE MEDIA WEAPONIZED JESSICA LYNCH'S STORY

2.1 General Context and Profile of Jessica Lynch. Jessica Lynch grew up in a small, tight-knit community in Palestine, West Virginia, where jobs were scarce, and many young people saw the military as a path to stability (Bragg & Lynch, 2003). After graduating high school, she enlisted in the Army primarily to afford college tuition, hoping to become a kindergarten teacher. In March 2003, during the early days of the Iraq War, her maintenance unit took a wrong turn near Nasiriyah and was ambushed. Lynch's vehicle crashed during the chaos, leaving her with severe injuries, including broken bones and spinal damage. Iraqi forces took her to a hospital, where she received medical care.

When U.S. Special Forces rescued her nine days later, the military and media transformed her ordeal into a sensational story. They claimed she fought fiercely before being captured—a lie she later debunked (Kumar, 2004: 300). Officials emphasized her "bravery" to boost public support for the war, ignoring the fact that her injuries came from the crash, not combat. This rewritten narrative turned Lynch into a symbol of American resilience, even though she repeatedly stated, "I'm just a survivor." (Bragg & Lynch, 2003: 45).

2.2 The Rescue: Truth vs. Fiction. The rescue mission on April 1, 2003, was carefully staged for the cameras (*The Washington Post*, 2003). U.S. forces knew the Iraqi hospital where Lynch was held had no enemy fighters, but they raided it at night using dramatic night-vision footage. Soldiers burst through doors with guns drawn, though the staff had already tried to return her to U.S. troops days earlier. Tragically, an Iraqi ambulance carrying Lynch's medical records and a peace offer was mistakenly bombed by U.S. jets the day before the raid (Kampfner, 2003).

The Pentagon released edited video clips of the rescue, making it look like a daring battlefield operation. In reality, Iraqi doctors had been caring for Lynch and even held a farewell party for her (Kumar, 2004: 304). The military's exaggerated account hid these details, instead portraying the mission as a heroic triumph. This misleading story aimed to distract from early setbacks in the war and boost morale at home , according to Jaramillo's analysis of Pentagon press strategies during the Iraq War, which revealed how officials "latched onto sensational versions of events" to shape public perception (Jaramillo, 2009: 215).. As Wells observes, "the media worked the facts of Lynch's rescue into an acceptable war story, following collectively accepted stereotypes of what a female prisoner of war might look like" (Wells, 2022: 6).

2.3 "The Manufactured Heroine": How Jessica Was Transformed into a Symbol. Media outlets like CNN and The New York Times falsely claimed Lynch had "fought to the last bullet" during her capture (Kumar, 2004: 301). They compared her to action heroes like Rambo, framing her as a symbol of female strength. Deepa Kumar, a media scholar, explains this was intentional: Lynch's image as a young, white, small-town woman made her relatable to mainstream audiences (Kumar, 2004: 298). Her story was twisted to fit a narrative of "good vs. evil," where the U.S. military rescued an innocent victim from brutal enemies.

This portrayal ignored the reality of Lynch's passive role in the ambush. Instead, it reinforced stereotypes of women as vulnerable yet brave, which helped justify the war as a moral mission. By focusing on Lynch, the media sidelined broader questions about the war's purpose, such as faulty intelligence about weapons of mass destruction.

2.4 Comparisons with Other Female Soldiers: Racism and Media Selectivity. Lynch's story overshadowed two other soldiers from the same ambush: Lori Piestewa, a Hopi woman and the first Native American killed in combat in Iraq (Wounded Warrior Project, n.d.), and Shoshana Johnson, a Black Army specialist who was shot in both legs and held captive for 22 days (CNN, 2005). Piestewa, a close friend of Lynch, died in the attack, but her story received little attention. Johnson, one of the first Black female POWs in U.S. history, was briefly mentioned as a "side note" in news reports (CNN, 2005).

Experts argue this disparity reflects systemic racism in media. Lynch, as a white woman, fit a "perfect victim" archetype that appealed to viewers, while Johnson and Piestewa's stories—tied to marginalized identities—were seen as less marketable (Kumar, 2004: 302). Their erasure perpetuated the myth that heroism in war is reserved for those who fit traditional, white-centric ideals.

2.5 The Film Saving Jessica Lynch: A Propagandistic Fiction. NBC's 2003 TV movie Saving Jessica Lynch exaggerated her ordeal, depicting her as a helpless victim saved by heroic soldiers (*Saving Jessica Lynch*, 2003). The film ignored key facts: her injuries were from a crash, not combat, and Iraqi doctors had tried to help her (Kampfner, 2003). Instead, it invented scenes of enemy fighters torturing Lynch and U.S. troops battling through gunfire to rescue her.

Journalists, then, more recently, theorists, such as Roger Stahl, who developed the concept of *militainment*, define this phenomenon as the use of entertainment to glorify war and present it as a consumer product. In his work *Militainment, Inc.*, Stahl argues that war has become a form of participatory spectacle, where media blurs reality and fiction to serve nationalist and military agendas (Stahl, 2010: 6-10). The movie erased Lynch's voice, focusing instead on military valor to paint the Iraq War as a noble cause. Lynch later criticized the film, saying it felt like "being exploited all over again." (Bragg & Lynch, 2003: 112). The film's inaccuracies show how media can twist real events to shape public opinion.

2.6 Jessica Lynch's Personal Testimony. In 2007, Lynch testified before Congress, rejecting the military's fabricated story. "They used me as a tool to create this myth," she said, stressing that her survival was due to luck, not heroism (Bragg & Lynch, 2003: 157). She redirected praise to soldiers like Lori Piestewa, who died in the ambush, and Shoshana Johnson, who endured captivity (Wounded Warrior Project, n.d.; CNN, 2005).

Her honesty sparked backlash. Some accused her of being ungrateful, while others called her a traitor (Kampfner, 2003). Despite this, Lynch continued advocating for veterans' mental health and criticizing media distortion. "The truth matters," she insisted, urging the public to question stories that seem too perfect (Bragg & Lynch, 2003: 204). Her courage in speaking out highlights the cost of forcing survivors into roles they never chose (Kumar, 2004: 310).

2.7 Public Reaction: Between Admiration, Confusion, and Hostility. Jessica Lynch's story caused mixed reactions from the public. Some people admired her as a hero because of the dramatic media stories, even though they were not true. Others were confused or angry, blaming her for "lying" or "using" the myth for fame—even though she did not create it (Kumar, 2004: 302). Jessica received hate mail and harsh criticism, but she kept telling the truth about what really happened (Bragg & Lynch, 2003: 189).

This backlash shows how hard it can be for people to accept that a heroic story was fake. Many wanted to believe the myth because it made the war seem noble (Kumar, 2004: 305). Jessica's courage in refusing to pretend she was a hero—even when others attacked her—highlights the importance of honesty, especially when powerful groups spread lies (Kampfner, 2003). Her experience reminds us that survivors of trauma should not be forced to become symbols for others' agendas (Bragg & Lynch, 2003: 212).

2.8 Academic Analysis: Deepa Kumar and Media Manipulation. Professor Deepa Kumar, a media scholar, studied Jessica Lynch's story as a clear example of how governments and media collaborate to shape public opinion (Kumar, 2004: 297; Stahl, 2010: 45). Her research aligns with Wells' (2022) analysis of how female soldiers' narratives are often mythologized to fit cultural expectations. Kumar explains that after the U.S. invaded Iraq in 2003, officials needed to frame the war as morally justified, leading to what Jaramillo (2009: 112) terms "high-concept war packaging."

Jessica's capture and rescue became instrumental in this effort. Kumar argues the media exaggerated Lynch's story into a patriotic symbol while ignoring facts—her injuries resulted from an accident, not combat (Kumar, 2004: 301; Bragg, 2003: 153). This selective framing, notes Stahl (2010), exemplifies "militainment"—the fusion of military and entertainment agendas.

Lynch was chosen for this role because she fit the military's preferred image of a hero: a young, white woman from a small town whose appearance and background made her story more appealing to mainstream audiences. News outlets amplified phrases like "female Rambo" (Jaramillo, 2009: 215) while marginalizing soldiers like Piestewa and Johnson, whose racial identities complicated the preferred narrative (Holmstedt, 2007: 92; Wells, 2022: 8).

2.9 Life After Captivity: Education, Career, and Activism. Post-captivity, Lynch pursued education to reclaim agency, earning a teaching degree—a trajectory Saunders (2024) links to veterans' frequent career shifts due to PTSD. Her advocacy work, particularly around veterans' mental health, reflects broader systemic failures documented in *The Girls Come Marching Home* (Holmstedt, 2009: 156–160).

Her activism wasn't just about her own story. She also raised awareness about the struggles of other soldiers, like her friend Lori Piestewa, who died in the same ambush, and Shoshana Johnson, a Black POW whose story was largely ignored. Jessica's goal was simple: to remind people that real war is messy, painful, and rarely as heroic as the movies make it seem.

2.10 The Cost of Forced Fame. The fake "hero" label forced onto Jessica Lynch came at a heavy price. The constant media attention left her feeling trapped and anxious. She struggled with PTSD, nightmares, and the pressure of being seen as a symbol she never asked to represent. "People treated me like a character in a story," she later said, "not a real person who was hurting." (Bragg & Lynch, 2003: 189).

Her relationships suffered too. Friends and family didn't always understand the stress she was under, and strangers sometimes accused her of "lying" or "seeking fame." Even her teaching career was disrupted by occasional media intrusions. Over time, Jessica chose to step away from public life entirely. She moved back to her hometown in West Virginia, started a family, and focused on raising her children.

Today, she avoids interviews and refuses to let her name be used in movies or documentaries. "I'm not a hero," she insists. "I'm just someone who survived." Her story serves as a warning about the dangers of turning real people into propaganda tools—and the importance of letting survivors tell their own truths, in their own time.

3. CONCLUSIONS & ACKNOLEDGMENT

This study reveals how Jessica Lynch's story was reshaped into a heroic myth by media and political agendas, despite the lack of combat in her experience (Kumar, 2004: 310). The erasure of soldiers like Lori Piestewa (the first Native American woman killed in combat) and Shoshana Johnson (a Black POW) highlights systemic racial and gender biases in storytelling (Wounded Warrior Project, n.d.; CNN, 2005).

Films like Saving Jessica Lynch further distorted reality, using entertainment to justify war (*Saving Jessica Lynch*, 2003). Lynch's rejection of this false narrative—and her advocacy for truth—underscores the ethical duty to prioritize facts over propaganda. Her journey reminds us that real heroism lies in honesty, not manufactured legends.

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PSYCHOLOGY OF THE MASSES AND MANIPULATION TECHNIQUES IN MILITARY OPERATIONS: STRATEGIES OF INFLUENCE AND CONTROL IN PSYCHOLOGICAL WARFARE

David-Florin RADU, Alexandru BUTURUGĂ-DELCEA, Sorin URSU

Coordinator: Prof. **Dănuța Mădălina SCIPANOV**, PhD

"Carol I" National Defense University, Bucharest, Romania

Abstract: *With an emphasis on current tactics of influence and control in psychological warfare, this article explores the psychology of the people and the manipulation methods used in contemporary military operations. The paper examines how new technologies like artificial intelligence (AI), social media, and cyber capabilities have been used to transform traditional psychological operations (PSYOPS) into complex cognitive warfare tactics. The integration of digital technologies with psychological techniques is demonstrated via case studies of contemporary conflicts, with a heavy focus on the conflict between Russia and Ukraine. The paper also examines the ways in which reflexive control strategies and AI-powered misinformation operations, including the spread of fake news, are being employed to destabilize societies and sway public opinion on a large scale. These techniques take use of flaws in human reasoning to accomplish strategic goals without using physical force. As such, this study demonstrates the revolutionary influence of cognitive warfare on current conflict dynamics by fusing historical understanding with contemporary applications, while also highlighting the moral dilemmas these tactics present, as they conflate military and civilian objectives, prompting serious concerns about their long-term effects on society.*

Keywords: *psychological warfare; cognitive warfare; PSYOPS; AI-driven disinformation; social media manipulation; fake news; Russia-Ukraine war.*

1. INTRODUCTION

With recorded instances going back to ancient civilizations, psychological warfare is among the oldest strategic methods used in mankind. Written about 500 BCE, Sun Tzu's „The Art of War" stressed dishonesty as the main weapon in combat and supported tactics meant to lower enemy morale before to actual conflict. From Roman military demonstrations to Genghis Khan's intimidation strategies, psychological manipulation has been crucial to battle over history. Originally from Germany, the term "psychological warfare" first arrived in the United States in 1941 and was formally acknowledged during World War II when the United States Joint Chiefs of Staff defined it generally as "employing any weapon to influence the mind of the enemy." This era saw the formal military strategy of psychological warfare consolidated under the direction of specialized forces set to carry out psychological operations. Military strategy has saw a radical change as conventional psychological operations (PSYOPS) give way to new cognitive warfare. The Gulf War changed the way battles were shown on media and marked a turning point in knowledge of psychological warfare. As observed by academics, „the basic means are not propagandas' messages and pamphlets, anymore. First priority is the selected TV stations, reporters, and journalists.

This progression intensified with the development of technology and creation of social networks, creating possibilities for conflict beyond classical meaning. While information warfare concentrates on controlling the flow of information, cognitive warfare instead has a more subtle but possibly more damaging goal of shaping not only what people think but also how they think and react to information. This transition from influencing specific ideas to controlling cognitive processes itself implies a dramatic escalation in psychological warfare capabilities.

2. THEORETICAL FOUNDATIONS OF MASS PSYCHOLOGY IN MILITARY CONTEXT

Mass psychology in combat circumstances reveals important vulnerabilities that can be exploited through psychological warfare. Collective conduct generally exhibits heightened emotional responses, diminished critical thinking, and increased susceptibility to suggestion. The effectiveness of psychological operations typically hinges on recognizing and exploiting these group dynamics. Contemporary psychological warfare operations acknowledge that target populations frequently react more to emotional appeals than to factual facts, especially when these appeals fit with existing views or worries. Research demonstrates that effective cognitive attacks essentially turn the prejudices of a population against itself. For example, in Germany, strategic competitors utilized existing biases against foreigners and immigrants to promote divisiveness and weaken trust in the European Union's future. This highlights how psychological warfare operations use inherent vulnerabilities in collective behavior to achieve strategic objectives without direct military action. Cognitive biases serve as major targets for psychological warfare tactics. As highlighted in study on cognitive warfare, „the effective use of cognitive biases fundamentally stirs a person's/target population's decision making to be directed by emotions rather than rationality, meaning rather by how information is presented instead of the genuine substance." (Narula 2004, 177)

Psychological warfare operations exploit heuristic decision-making processes developed by Kahneman and Tversky, wherein humans use mental shortcuts to arrive at decisions; these operations don't create biases but identify vulnerable population segments and leverage existing biases through various information channels. The heuristic decision-making process enables influencers to take advantage of built-in biases, not by manufacturing them, but by effectively identifying vulnerable people and employing cyber technologies or other information distribution channels to forward intended messages. Social identity theory provides another theoretical framework for analyzing psychological warfare success, as this theory explains how individuals get part of their identity from group membership, causing in-group preference and out-group antagonism. Modern psychological warfare sometimes leverages these processes by exacerbating differences between social groups. As seen in research on genetic foundations of warfare, group identification mechanisms serve as critical linkages in conflict development, and by targeting group identities and exacerbating existing tensions, psychological warfare can fragment social cohesion and undermine collective resilience against external influence operations. Contemporary operations frequently employ sophisticated segmentation approaches that identify specific identity vulnerabilities and develop tailored messaging strategies to exploit them - demonstrating how theoretical understanding of social identity dynamics translates into practical psychological warfare applications. (Vailliant and Ajir 2020, 3)

3. MODERN TECHNOLOGIES TRANSFORMING PSYCHOLOGICAL OPERATIONS

Social media platforms have become main battlegrounds for contemporary psychological warfare, giving unparalleled possibilities for targeted influence operations. These platforms allow direct access to enormous audience segments with limited monitoring, enabling precision targeting based on demographic, psychological, and behavioral aspects. The Russia-Ukraine war shows how social media amplifies disinformation efforts, with Russian propagandists flooding the information space with various sorts of low-quality content generated by AI (Mishra 2022, 747). These operations use platform algorithms that favor participation, unwittingly pushing divisive or emotionally charged content that serves strategic psychological warfare aims. Research indicates that Russia has utilized the information vacuum to launch such AI-generated videos, however their success has been restricted by the low quality of the deepfakes and the swift response of fact-checkers and Ukrainian government sources. Nevertheless, the increasing volume of content makes it impossible to discriminate between what is true and what is fraudulent, causing enormous hurdles for information integrity in conflict zones. Artificial intelligence has also changed psychological operations through better capabilities in target audience analysis. Machine learning algorithms evaluate enormous datasets to detect psychological vulnerabilities and forecast reactions to certain marketing methods. AI enables precise targeting, personalized messaging, and content automation through behavioral analysis and sentiment analysis, which, in turn, allows military strategists to create detailed audience profiles based on social media activity, browsing history, and interaction patterns, facilitating the development of tailored psychological operations that align with the psychological and emotional triggers of each demographic. AI-driven profiling creates detailed audience profiles, enabling psychological operation professionals to build communications that correspond with distinct psychological triggers of each demographic segment. Furthermore, AI automates persuasive content development, from text to deepfake films, making it possible to scale psychological operations beyond prior restrictions. This incorporation of AI into psychological warfare signifies a paradigm change from broad propaganda tactics to highly individualized influence campaigns. (Barnett and Lord 1989, 3)

Psychological warfare operators may also manipulate information environments with the use of advanced cyber skills. These technologies allow for actions that go beyond the simple distribution of messages, such as data tampering, system penetration, and communication interruption. By disseminating specific information to alter public awareness, modern cyberpsychological operations affect the people of another state. Because psychological operations may promote cyber objectives and cyber intrusions can have psychological consequences, combining the two produces synergistic benefits. According to research on contemporary wars, cyberwarfare has become a crucial element of these conflicts, impacting military strategy, national security, and international stability. Important strategies include malware, cyber-espionage, and Distributed Denial of Service (DDoS) operations; Russia's cyberattacks against Ukraine are a prime example. This confluence produces all-encompassing strategies for dominating the information environment, illustrating how contemporary technology have radically changed how psychological warfare is conducted. (Mishra 2022, 747)

4. CASE STUDY: RUSSIA-UKRAINE CONFLICT

The Russia-Ukraine conflict is a premier case study in contemporary psychological warfare, with strategic story production functioning as a vital component. Russia has developed sophisticated narrative frameworks that question Ukraine's sovereignty and legitimacy while positioning Russian actions as defensive responses to perceived threats, and these narratives employ historical revisionism, selective information presentation, and emotional appeals to shape perceptions among domestic and international audiences. According to research, Russian propaganda and fake news reports have assailed Ukraine's right to exist and accused it of being a neo-Nazi state, committing genocide against Russian speakers. These narratives are deliberately broadcast across many channels with messaging tailored to specific audience segments, exhibiting advanced grasp of narrative influence strategies in modern psychological warfare. (Dolev 2022, 2) The analysis of Russian military aggression against Ukraine reveals it as a noteworthy example of hybrid warfare combining both direct and indirect military measures with large-scale disinformation and public consciousness manipulation campaigns. Despite the large-scale tactical operations that began in February 2022, the war remains hybrid in nature, with cognitive warfare serving as a vital component of Russia's strategy.

In order to maximize their influence, Russia's psychological warfare operations in Ukraine employ complex cross-platform misinformation tactics that make use of a variety of media outlets. These campaigns combine websites, messaging apps, social networks, and conventional media into well-planned information offensives. The cross-border character of these operations is noteworthy; information frequently originates in Russia but is distributed worldwide via amplification channels and proxy networks. According to reports, Russian propagandists have inundated the information space with a variety of low-quality AI-generated material because of how inexpensive and simple it is to create content. Deepfakes of Ukrainian authorities and military people are frequently used in these efforts, resulting in one of the most harmful AI products that are emotive, brief, and capitalize on the prejudices and unhappiness that are prevalent in both the Ukrainian military and public (NATO Allied Command Transformation 2024). Numerous AI-generated images, deepfakes, and text creation have been reported in studies, both for posts and comments aimed toward Ukrainian audiences. Information verification and authentication procedures in conflict areas face significant obstacles due to the quick spread of these fake media goods.

Ukrainian reactions to Russian psychological warfare efforts have evolved to encompass sophisticated countermeasures and resilience-building initiatives. Ukrainian authorities have established rapid response tools to identify and refute disinformation, often using social media for swift corrections. As observed in study, these countermeasures have been mainly owing to the low quality of the deepfakes and the swift response of fact-checkers and Ukrainian government sources. Additionally, civic organizations, media literacy programs, and multinational alliances have enhanced societal resilience against psychological deception. However, issues remain as the rising volume of content available makes it impossible to discriminate between what is real and what is fraudulent. Research on Russia's social-impact operations in Ukraine identifies the creation and proliferation of information threats as a critical security challenge, highlighting the growing impact of communication processes on global security and examining the impact and role of mass media on the shaping of people's minds, by exposing the mechanisms behind the formation of public opinion. This story highlights both the vulnerabilities exploited by psychological warfare and the possibilities for building effective defenses. (Buchanan et al. 2023)

5. OTHER EXAMPLES OF PSYCHOLOGICAL WARFARE

While the Russia-Ukraine conflict provides a detailed case study, other historical and contemporary cases offer further insights into psychological warfare evolution. During the Cold War, psychological operations were important to ideological battle between the United States and Soviet Union. The U.S. Information Agency was founded to transmit American principles abroad through programs like Voice of America and Radio Free Europe, combating Soviet influence through cultural and informational channels. In more recent conflicts, psychological operations have adapted to specific regional situations. For instance, psychological warfare in the Arab context has moved towards 'nonviolence' as a political strategy, where operations share goals with public diplomacy as a way of influencing legislation. This method comprises convincing and cynical strategies that typically involve a disregard for and exploitation of civilian losses and the appearance of adopting ideology linked with revolutionary figures and human rights. Ambassador Clare Boothe Luce's psychological warfare activities in Italy during the 1950s indicate how such operations can be balanced between frontal attack on communist power and smart use of diplomacy, influencing the interplay between home and foreign policies. These different instances highlight how psychological warfare strategies adapt to specific cultural, political, and technical situations while keeping essential concepts of influence and control. (Stancu and Căzănaru 2024)

6. ADVANCED MANIPULATION TECHNIQUES IN CONTEMPORARY WARFARE

Reflexive control is one of the most sophisticated psychological warfare tactics in current military operations. Defined as power someone has over their opponent's decisions by imposing on them assumptions that influence the way they act, reflexive control originated in Soviet military theory but has found widespread current applications. This strategy focuses on manipulating an adversary's decision-making process by delivering carefully prepared information that convinces them to willingly make planned conclusions advantageous to the initiator. As mentioned in study, the essential feature of reflexive control is implicitly forcing a subject to choose a desired conclusion. Vladimir Lefebvre, a Soviet researcher, defined reflexive control as a process in which one adversary turns over to the other the basis for decision-making, effectively substituting incentive variables to encourage adverse judgments. Methods of reflexive control are commonly employed across numerous fields including advertising, public relations, and military operations (Putra, Wirajuda, and Risman 2024). The complex nature of reflexive control makes it particularly effective against advanced enemies, as it acts within their own decision-making systems rather than through direct confrontation. Artificial intelligence has transformed misinformation operations with automated content generating and delivery capabilities. Contemporary psychological warfare increasingly leverages AI to create persuasive synthetic content that appears authentic but contains purposefully created falsehoods. As highlighted in studies, AI automates the development of persuasive information, from text to deepfake movies, making it easy to scale psychological operations. These characteristics enable the generation of volume and variety of content that overwhelms verification systems, generating information environments where truth becomes indistinguishable from fabrication. (NATO Strategic Communications Centre of Excellence 2022)

AI distribution systems further increase these impacts by targeting content delivery based on psychological profiles, interaction patterns, and network weaknesses. Research

on cinema as a tool of cognitive warfare notes that achievements in the sphere of high technology, associated with information operations and using the tools of 'soft power', make it possible to introduce false paradigms, falsify meanings and values into the minds of large masses of people. The combination of AI-generated material with algorithmic dissemination enables unparalleled potential for mass manipulation while maintaining plausible deniability for the originators. Deepfake technology represents a particularly concerning advance in psychological warfare, enabling the creation of highly convincing synthetic media that can radically impact public opinion. These technologies can generate video and audio content that purports to show actual humans saying or doing things they never did, weakening basic trust in audiovisual evidence. As highlighted in study on the Ukraine crisis, deepfakes typically include Ukrainian President Zelenskyy and Commanders-in-chief Valeriy Zaluzhnyy and Oleksandr Syrskyy, or footage of pseudo-soldiers in the trenches. These synthetic media operations are designed to be emotive, brief in duration, and play on stereotypes and discontent, maximizing psychological impact. The advent of natural language generation algorithms and deepfake technology has enabled AI to generate tailored narratives that resonate with target audiences, presenting severe ethical problems regarding manipulation, consent, and individual autonomy. The strategic deployment of deepfakes can construct misleading narratives regarding leader decisions, military actions, or civilian circumstances that influence both internal and international perceptions, revealing how synthetic media has become a strong tool in current psychological warfare. (Bergmanis-Korāts, Haiduchyk, and Shevtsov 2024)

7. ETHICAL CONSIDERATIONS, FUTURE IMPLICATIONS AND METHODS OF COMBATTING COGNITIVE WARFARE

Contemporary psychological warfare poses substantial ethical difficulties through its systematic blurring of boundaries between military and civilian sectors. Unlike conventional warfare with clearly defined soldiers and battlefields, cognitive warfare purposefully targets civilian populations, frequently without their awareness or agreement. Research emphasizes that cognitive warfare strategies tend to target but are not unique to civilian populations, civilian social infrastructures and governments. This targeting of civilians raises basic problems about the ethics of modern warfare and contradicts existing frameworks of international humanitarian law. Research on cognitive warfare in Ukraine emphasizes that it comprises tactics to acquire human capital with the objective of controlling communities through targeted information campaigns and psychological operations. The interplay of diverse aspects such as non-trinitarian war, network warfare, managed chaos, reflexive control, information warfare, and neorealism in international relations presents complicated ethical dilemmas. (Mishra 2022, 747)

Additionally, the indirect character of psychological harm complicates attribution and accountability, as psychological operations typically operate in legal and ethical murky zones. These innovations need rethinking of ethical theories regulating combat to reflect the particular issues provided by operations targeting cognitive processes rather than physical bodies. The regulation of cognitive warfare raises serious issues for international law and governance frameworks. Traditional laws of armed conflict were created largely for kinetic combat and struggle to address psychological operations that occur below conventional conflict thresholds. The global character of information flows further complicates regulatory approaches, as activities often span jurisdictional boundaries and include various actors with varying legal statuses.

Additionally, the rapid advancement of technologies enabling cognitive warfare outpaces regulatory development, producing chronic governance gaps. As observed in study on the Russia-Ukraine conflict, these obstacles underscore the ethical issues inherent in Russia's use of cognitive warfare and its strong dependence on disinformation. The research of the information component of hybrid warfare demonstrates that geopolitical rivalry not only does not cease, but gains new forms in the current information and digital world, with information and psychological operations becoming main means of rivalry. Addressing these difficulties demands novel methods to international cooperation, technical standards creation, and legal frameworks that may effectively manage the cognitive dimension of conflict. (Barnett and Lord 1989, 3)

8. METHODS OF COMBATTING COGNITIVE WARFARE

Table I. Methods of combatting cognitive warfare

Method	Description	Implementation Level	Effectiveness
Media Literacy Education	Programs developing critical thinking skills to evaluate information sources and identify manipulation	Individual/ Community	High long-term impact but requires sustained effort
Rapid Fact-Checking Systems	Infrastructure for quick verification of claims and debunking of false information	National/ Institutional	Moderate effectiveness for specific claims but struggles with volume
Cognitive Security Frameworks	Comprehensive approaches treating cognitive security as a national security priority	National/ International	High potential effectiveness but complex implementation
Platform Governance	Regulatory frameworks requiring transparency and accountability from information platforms	International/ Corporate	Moderate effectiveness dependent on enforcement capabilities
Technical Countermeasures	Tools for identifying synthetic media, bots, and manipulation techniques	Technical/ Institutional	High effectiveness for specific techniques but requires continuous updating
Strategic Communications	Proactive communication strategies that preempt and counter adversary narratives	National/ Institutional	Moderate effectiveness dependent on credibility and reach
International Cooperation	Multilateral initiatives addressing cognitive warfare through shared standards and responses	International	High potential impact but faces significant coordination challenges
Resilience Building	Programs enhancing societal cohesion and resistance to manipulation attempts	Community/ National	High long-term effectiveness but difficult to measure and implement

9. CONCLUSIONS & ACKNOLEDGMENT

This research of psychological warfare in contemporary military operations reveals numerous major findings. First, psychological warfare has developed from old propaganda tactics to sophisticated cognitive operations attacking core mind processes. Second, current technology, notably artificial intelligence and social media platforms, have drastically revolutionized psychological operations capabilities, providing unparalleled precision in targeting and content development.

Third, the Russia-Ukraine conflict reveals how these advanced approaches appear in contemporary warfare, with strategic narrative fabrication, cross-platform deception, and synthetic media playing major roles. Fourth, modern manipulation tactics involving reflexive control and AI-powered misinformation present particularly challenging risks to information ecosystems and democratic processes. Finally, the ethical consequences of these innovations are considerable, as they systematically erode boundaries between military and civilian sectors while working outside established regulatory structures. Several intriguing research directions appear from this analysis. Further inquiry is needed addressing the long-term psychological impacts of protracted cognitive warfare on target populations, notably effects on social trust, institutional legitimacy, and collective decision-making. Additional study should explore the success of various cognitive warfare countermeasures, providing empirical frameworks for evaluating resilience projects. Technical research should focus on enhancing detection capabilities for synthetic media and algorithm-driven manipulation, while social science research should study vulnerability factors that predispose certain populations to manipulation. Interdisciplinary approaches integrating technical, psychological, and security views offer particularly interesting options for addressing the complex issues posed by cognitive warfare. These research topics would provide useful insights for both defensive and normative reactions to emerging psychological warfare strategies. Based on the findings of this research, various strategic recommendations emerge for resolving cognitive warfare difficulties. Governments should build comprehensive cognitive security frameworks that include technical, pedagogical, and strategic communication techniques. International collaboration should focus on establishing rules and accountability procedures for information operations, particularly those targeting civilian populations. Media literacy programs should be expanded and adapted to address evolving manipulation techniques, with emphasis on strengthening critical thinking skills rather than simply fact-checking capabilities. Platform governance could boost transparency about algorithmic amplification and content provenance, creating situations where manipulation becomes more evident. Finally, societal resilience should be fostered through programs that build social cohesion and common epistemic frameworks. These multilayered approaches emphasize that effective responses to cognitive warfare involve collaboration across technical, social, and political dimensions.

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THE STRATEGY OF FEAR: HOW DOES THE TERRORISM PSYCHOLOGICALLY WORK

Marian-Sebastian PARASCA

Coordinator: **Emil-Răzvan GÂTEJ**

"Alexandru Ioan Cuza" Police Academy, Bucharest, Romania

Abstract: *Psychobehavioral sciences and the field of public order and national security are strongly related, considering the idea that people represent the work object: authorities work with different types of individuals, victims, witnesses, perpetrators and this is why this type of personnel has and must know how to communicate and cope with any situation that might come across. Terrorism is known as a tough subject, a complex deviation of the society, hardly noticeable, despite the multiple causes, modus operandi and social implications this phenomenon has. The specificity of this act is precisely represented by the effects that the act produces on groups of people; even an isolated event, whose target is represented by a single person, produces effects that are felt at the level of the entire social group. The way of working is usually a well-thought-out pattern, in the idea that the terrorist targets vulnerable people, prone to arouse feelings of pity among the media channels and the population. The current article aims at the psychological implications that terrorism has on the victim, his transformation from a common person into an object, an instrument of manipulation and intimidation. The terrorist must be seen as more than a threat, he must be studied from a psychological perspective, in order to anticipate similar tendencies.*

Keywords*: victim, psychology, vulnerabilities, manipulation, to identify with a group.*

1. INTRODUCTION

Terrorism dates back to the earliest periods of humanity. Terror, fear and anxiety are feelings that have always been induced by individuals and organizations with a certain influence, in order to externalize ego and lack of empathy towards other people, witnesses of atrocities. In other words, the image of a struggle for supremacy is imprinted, in which the main actors are the malicious individuals and the victims. Regardless of the circumstances in which feelings of terror were propagated, the basis, the motivation has always been the same: the cultivation of horror.

Starting from a simple search for the concept of terrorism on the Internet, we discover that this term does not have a pre-established, unanimously accepted definition; its complexity, respectively the multitude of organizations involved in preventing and combating this ascendancy, attributes to terrorism a definition based on the relationship between purpose and method. Terrorism manifests itself through violence, intimidation, general panic and the loss of innocent lives. Individuals who resort to this method call on the indirect help of vulnerable people whom they transform into victims, a situation in which media channels focus all their attention on the targeted group, and, implicitly, on the phenomenon and its author/authors.

Perceptions of terrorism have evolved and sharpened throughout history, thus becoming a subject of interest.

In the 70s and 80s, it was believed that terrorism would not reach the stage of using weapons of mass destruction, but would resort to simple manifestation by using the victim in order to attract the attention of people, authorities and the media. Brian Jenkins, a prominent personality, an American expert in terrorism and transport security with five decades of experience in analyzing the phenomenon, mentioned that "Terrorism is theatre: terrorists want a lot of people watching, not a lot of people dead."[1] This statement precisely states the passive nature of terrorism at that time: the aim was to generate panic and receive attention, given historical examples that confirmed that at that time acts of mass destruction, characterized by a large number of victims, were not resorted to.

2. VERIFICATION OF THE ASSUMPTION

A. SEPTEMBER the 6th, 1970: On September the 6th, 1970, the Popular Front for the Liberation of Palestine began a series of hijackings in furtherance of its cause. Three planes were hijacked on September the 6th, and one plane each on September the 9th and the 12th, with the terrorists ultimately setting the planes on fire. The terrorists released the passengers in exchange for prisoners, which underscores the nature of terrorist attacks during that period. The aim is to intimidate and channel attention to the phenomenon through the media, but the end result is in favor of the terrorist, who achieves his goal, but it is important to note that there was no loss of innocent life. What happened as a result of this incident? Israel has changed its flight regulations, adopting increased security measures, and terrorism has received greater attention, considering the effects that a wrong decision could have.

B. MARCH the 20th, 1995: Chizuo Matsumoto became known to the authorities when he was caught with counterfeit medicines, which incriminated him and forced him to spend several years in prison. That failure materialized in a frustration that would take the shape of the case I am presenting now. The man no longer identified with the name he had, so from that moment on he introduced himself as Shoko Asahara. This identity crisis is worth noting, his former name associated him with failure, so his gesture is logical. The story of the 1995 attack has its origins around 1984, when Shoko attracted people from various social categories to a group formed for the purpose of practicing yoga, known as Aum Shinrikyo. Asahara seeks to add influential people from various fields of activity to his group, and even motivates participants by offering benefits in exchange for loyalty. Followers were ranked according to loyalty, and the guru deprived them of contact with their family and the outside environment, erasing their identity by assigning them new names. The group of people formed was deprived of sleep, freedom, goods and were subjected to difficult-to-digest training, the reasoning being that the practice was carried out in order to remove bad karma. Mass prayer sessions and repeated kneeling are used, in addition to exploitation through unpaid labor. It is worth noting the ideology it promotes, invoking the idea of karma, Shoko justifies acts of torture, deprivation of freedom and vital means. The idea that the leader propagates in his sphere of influence is that people outside the group are carriers of bad karma, and they, the members of the association, are benefactors, people who were delegated by their leader to kill, in order to save the rest in the afterlife from a cruel fate. The typology of this character is characterized by the apocalyptic thoughts that he emanated and promoted: he said that the end of the world was approaching, a war between the great global powers. Through these premonitions, he caused unrest among the group, which made them vulnerable and turned them into tools.

Asahara's group obtained income from the confiscation of members' assets, and over time, with the help of intermediary companies, they obtained chemical substances that they would later use to develop weapons.

With the passage of time, especially in 1989, the group is legally established as a religious organization and more and more students from prestigious universities choose to conform to the principles and ideologies of the gathering. In 1993 they began making homemade weapons, then developed experiments on the streets of Tokyo to see the effects of the substances created on the environment, air, living things, but without result, and in 1995 they were already perpetrators of assassinations, sarin gas attacks. The authorities obtained clues from the locals regarding the origin of the smell of sarin gas, which made Matsumoto's plan more difficult. The date of March the 20th , 1995 was the peak of the group, five members chosen by Asahara would leave on five different routes of the Japanese subway, all having the center of the capital as their common point. They used cardboard bags, newspapers, gloves and umbrellas with which they would prick the outer layer of this container. Sarin gas was released into the subway cars, and passengers complained of symptoms of dizziness, vomiting, headaches, and coughing. Meanwhile, the perpetrators injected themselves with an antidote provided by the conductor, which helped them cope with the gas, while they evacuated the subway to the next station. The result? 14 deaths and approximately 6,300 injuries.

Shoko Asahara's motivation places his acts of organizing and coordinating the cult within the scope of terrorist acts, considering the means, purpose and manner of execution of the act. Thirty years after the attack, the phenomenon has made it possible to notice some differences applied in order to prevent the occurrence of such moments: the addition of video surveillance systems, public order and security personnel, national plans and strategies for the response of medical professionals to biological disasters. Emphasis has been placed on awareness of the phenomenon and its effects, and inter-institutional collaboration has experienced an ascendancy.

As a conclusion to all the aspects presented above, I would like to emphasize the dynamics of the terrorist phenomenon. If around the 1970s-1980s it was carried out mainly with the aim of promoting an ideology, in the sense of expressing an inner desire, but without seriously harming the community, today, the simple idea of gaining attention from states and media channels has turned into a complex issue, with the increase in the number of victims and the ways and methods adopted to satisfy the interest. As we pointed out through the examples presented, the terrorism of the 90s differs from that of the 70s. We note that the political side is no longer so prominent, compared to the personal one, the lack of identification with moral social groups, which automatically leads to deliberate or disguised association with criminal groups. The development of weapons of mass destruction determined a critical moment, thus realizing what the consequences of ignoring terrorism could be.

3. PSYCHOLOGICAL IMPLICATIONS

What interests us most and is the subject of this work is the genesis of human aggression, how a person ends up adopting behaviors associated with organizations with such ideologies, what are the behaviors predisposed to adherence and how the adherence process unfolds from the perspective of both parties, terrorist and victim. The aggressor clings like a parasite to the victim's vulnerabilities, uses the person, most often even reaching the point of extermination which, implicitly, triggers effects at the level of the entire species, in this case the community to which he belongs, the social circle.

In order to make it possible to present a person as a victim, an individual vulnerable to being drawn into the terrorist's psychological game, it is important to give this process a name: radicalization. Radicalization represents a cross-border threat that has been gaining ground in recent times, given the frustrations accumulated by people. Adopting an ideology contrary to the democratic status transforms the person into an ideal instrument of control, because the terrorist offers a sense of understanding and belonging. It is important to emphasize that there is no typology of the victim, a profile that can help us find out how someone becomes radicalized and how they will manifest themselves. Some people are in a latent phase for a long time, a moment that is difficult to detect even by people close to them, but this perspective changes when a trigger is triggered. That is the moment when those close to them discover the threat and turn to the authorities in order to deradicalize the person and bring them on the right path.

In this case, there is also an edifying example: a 15-year-old boy, lacking friends or hobbies, therefore a big minus on a social and personal level, but with very good results at school and above-average intelligence, is in a tense state with his mother, although his older brother advises him to get back on the right path. No one is aware of the situation he is in, which is why the dilemma stated above appears here: is it a simple episode of rebellion or an indicator of deviant behavior, prone to explode? In this case, the young man spent a lot of time online and became increasingly aggressive and contradictory towards his mother, but without producing a concrete deed to substantiate his behavior. Discovered in 2015 that he frequented forums related to terrorism, he resorts to converting to Islam, an easy procedure to follow, without the need to carry out a formal procedure in front of a representative of the denomination. The teenager filmed himself, in the appropriate attire that only requires showing his eyes, and came into direct contact with a member of Daesh. Two years later, the young man makes a confession to a friend about his intention to harm his mother, the colleague tells his parents and they call the authorities. This was the moment the authorities needed to be able to initiate contact with him, in order to determine the origin of the behavior and identify dysfunctions. The young man led an isolated life, present only in the online environment on forums, hence the feeling of belonging to the group with which he initiated contact. He felt understood, part of a group, a significant part even. The authorities held discussions with both the child and the parent, in order to understand the phenomenon. The most important thing in deradicalization is the parent's attitude towards the young man, a hostile, violent attitude could have amplified his beliefs, would have fed his desire to resort to violence.

The previous example only highlighted the relevance that early age has in implanting an ideology contrary to moral ones. But this phenomenon is gaining momentum not only among young people, but also among adults. Again, the lack of belonging to a group plays an important role, personal, material and political frustrations fuel the desire to make a change, and when they notice that a change does not take place amicably, less legal methods are resorted to.

As previously mentioned, adolescence is a period conducive to the development of abnormal feelings and ideologies, contrary to good morality and the rules by which a state is guided. In 2015, the terrorist attack took place, the target of which was employees of the famous journalistic publication Charlie Hebdo. It seems that that attack remained in the minds of the population for a long time, especially if we are talking about certain categories of people. This is validated by the incident that followed in October 2020. Samuel Paty was a professor of civic education and social sciences who chose, in his lectures on freedom of expression, to present cartoons belonging to the aforementioned publication. Moreover, he asked Muslim students who felt offended to leave the class, simply out of the desire not to arouse waves of indignation.

He was accused of even presenting a pornographic cartoon depicting Muhammad, a fact that was later denied, after the false testimony of a student who admitted her intention and the fact that she was not present at classes that day came to light, her action being brought under pressure from her father who, together with other parents, were organizing movements against the teacher. This parent had communicated with Anzorov nine times within a four-day period after the publication of defamatory materials against Paty. We can see that the victim of this attack was an individual with a high social status, a respected teacher in the community, married, with a child, who simply chose to present his ideas in a controversial context.

An important aspect in the analysis of this case is represented by the terrorist. Abdoullakh Anzorov, an 18-year-old young man, born in Moscow and raised in France at the age of 6, of Chechen ethnicity, obtained refugee status, lives 100 kilometers from the scene of his crime, from this we can deduce that he has no personal connection with the teacher, there is no previous conflict that has become acute, so the event took place as a result of the controversial course. Here it is not about the young man's isolation, personal or financial difficulties or sudden changes in his life that would have triggered this impulse. The impulse was caused by the feeling he felt after participating in the course held by the teacher, during which he presented defamatory materials against Muslims. The student felt that he had been indirectly attacked through the compromising of the image of Mohammad, his spiritual guide, which led him to accumulate frustration and manifest it, as French President Emmanuel Macron declared, "like an Islamic terrorist attack." It is important to note that his half-sister was already part of ISIS, and the young man was in direct contact with Russian citizens in Syria, to whom he confessed his desire to become a martyr by killing the teacher because of the dishonorable images shown. A month before the attack, Anzorov had applied to enroll in security courses, a request that was rejected based on a violent history.

October 16, 2020, the date of the attack. Helped by two students whom he asked to identify the teacher when he finished his classes, Anzorov resorted to the attack using a long-bladed knife, causing several wounds, followed by his beheading and posting the images on his Twitter account. Confronted by the police, Anzorov fired at them; the response of the law enforcement agencies was firm, they killed him with nine gunshots.

4. THE TERRORIST'S PERSONALITY

A conflict of perceptions arises due to the idea that the terrorist is an insane, mentally ill person, but with an interesting vision comes Walter Laqueur who states that "terrorists are fanatics and fanaticism frequently leads to cruelty and sadism." The human personality represents a complex area, made up of all the traits of an individual, the effects that intellect and physical appearance produce in society. The terrorist is a special typology of society that, from what we have seen in the above, has gained greater attention in recent decades, with the global popularization of certain ideas and concepts. The terrorist considers himself a victim, the only person able to sacrifice himself for a general good from his point of view, which is, in fact, altered. His motivation exceeds reason, therefore he resorts to extreme methods and means, in accordance with his deviant perceptions. There are several opinions on this phenomenon, but what caught my attention the most was what Air Flotilla General Ion-Aurel Stanciu said about the terrorist, stating his opinion according to which the terrorist is a "person conditioned by a deformed personality, which determines him to commit atypical, antisocial actions". The reality of the terrorist differs from that of other members of society.

It is important to say that there is no template for the terrorist, even if our first thought when hearing about this phenomenon of terrorism is that of an armed, dangerous individual with mental health problems, blinded by the desire to shed blood. Not all terrorists resort to such gestures, not all terrorists have political goals.

In most cases, the political context is irrelevant, emotional involvement in a cause, unfulfilled emotional gaps, frustrations and shortcomings are the basis of motivations. In this regard, I discovered a profiling developed by C.A. Russel and C.H. Miller in 1977 which includes notions regarding the identification of common characteristics of terrorists, things found after studying over 350 terrorists from various international groups, over a period of ten years, terrorist groups such as the Japanese Red Army, Red Brigades (Italy), Black September Organization (Palestine).

Age is a first indicator studied by the two officers, who led to a common conclusion on the phenomenon: we must make a difference between active terrorists and leading terrorists, thus the average age of active terrorists is lower than that of leading ones. In general, the average age of active terrorists was 22-25 years old, with certain exceptions: the revolutionary groups in Japan, Palestine and West Germany had an average age of 29 years old, a fact due to the composition of the group, determined by mature people, with education, associated with state systems such as the medical and legal ones.

From a gender perspective, the protagonists are men. Over 80% of the actors of terrorist groups were determined by men in the period studied, 1966-1976. An exception in this regard is established by the Tupamaros group in Uruguay, which used predominantly women in the materiality of support, more precisely for the purpose of gathering information, spreading propaganda, false documents, medical assistance and keeping protocol houses and weapons.

Marital status was studied in terms of flexibility and time dedication to the interests of the organization; in this way we can identify vulnerabilities of married people such as the possibility of being blackmailed, subject to emotional pressures. Statistics say that over 80% of terrorists were single, and married ones were subject to problems, their organizations facing operational dilemmas.

Regarding the rural or urban origin of the terrorist, it was stated that the most important aspect is knowledge of the terrain, regardless of its nature. The nucleus of a group is located in the urban environment, but members also come from rural areas in order to expand the influence and knowledge of the area of competence.

Socio-economic history was shown to be an important indicator in the study. Two-thirds of the arrested individuals came from at least the middle class, or their parents were influential people. Uruguayan Chancellor Jorge Peirano Facio declared in 1970 that in every upper-class family (above the middle class) there was at least one Tupamaro member (a Uruguayan guerrilla terrorist group with Marxist-Leninist beliefs).

Educational status is high in this study, as 75% of Tupamaro members could be proven to have higher university degrees. The academic fields they focused on included history, economics, sociology, and psychology.

5. CONCLUSIONS

Terrorism is a complex and deeply destructive phenomenon, affecting not only the physical security of individuals and the stability of states, but also the psychological balance of populations. By its unpredictable and violent nature, terrorism creates a generalized climate of fear, insecurity and distrust, affecting the mental health of both direct victims and secondary victims, namely the community associated with the primary victim and, last but not least, society as a whole.

Psychological implications include post-traumatic stress disorder, anxiety, depression and long-term behavioral changes. Its social effects include the polarization of communities, the increase in interethnic or religious tensions and the restriction of civil liberties in the name of security.

Faced with this phenomenon, a balanced response is essential that combines security measures with psychological support and the promotion of dialogue and tolerance, in order to prevent radicalization and strengthen the resilience of society.

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THE INFLUENCE OF THREE GENERATIONS AND OF AI OVER GENDER DISCRIMINATION -THE MORALE IN THE MILITARY -

Bianca-Ștefania VARVARA

Coordinator: Col. Assoc. Prof. **Cosmina-Oana ROMAN**, PhD

"Henri Coandă" Air Force Academy, Brașov, România

Abstract: *When it comes to human interaction, is there ever a perfect way to optimize communication between individuals in the military field? As we must have already recognized patterns of gender discrimination all around us through the years, it is important to unmask this phenomenon's impact on a specific community: the military. This field is supposed to be constantly changing for the better and we are responsible to make sure its course doesn't get affected by civil matters, such as propaganda and fake news. Over the years, the military has developed ways to improve inner matters, as if creating a world inside the units' walls would keep outside problems-outside. This paper aims to ensure that transparency as an act of trust between the military and the civilians remains intact as we try to solve gender discrimination issues that have broken through the gates of the military units. Before wearing the uniform, every soldier is a human being and that should not be forgotten, but protected. Military personnel are solely responsible for ensuring a best work performance, no exception. The first step into solving an issue is admitting there is an issue all along. In order to do that, I invite you to be a part of our journey as I analyze the impact of gender discrimination from the eyes of three generations and a representative of AI. My study's purpose is to help with future guidelines of gender equality to implement in the military fields.*

Keywords*: gender; community; transparency; performance, military.*

1. INTRODUCTION

This research suggests that the differences between generations and AI (artificial intelligence) influence gender discrimination in the military. It seems that military morale, including ethics and values, plays an important role in the way these influences manifest, especially in Europe. This research will be based on an analysis of Portugal, in order to have a comparison study to Romania. An unexpected detail we will find is that AI can both amplify and reduce gender discrimination, depending on the way it is implemented.

The methodology and the structure of this paper will comprise the following: introduction in the terminology and context of the study, importance of the study, analysis of interviews, from both civilians and officers' perspectives, from three generations (Gen X, Gen Y/Millennials, Gen Z), AI in the military, expected results.

2. THE DYNAMICS OF GENDER INEQUALITY

2.1 Introduction in terminology and context of the study. Women's participation in the workforce is at the heart of debates regarding gender equality. In the context of the military, many researchers argue that institutional practices are responsible for many of the gendered barriers women face in masculinized workplaces. (Santos, 2022)

Discrimination based on gender (or sex) is a common civil rights violation that has many forms. This discrimination can include sexual harassment, pregnancy discrimination, and unequal pay issues.

Sex discrimination happens when you're treated unfavorably based on your sex, or biological characteristics. Gender discrimination is a type of sex discrimination. Gender refers to socially constructed characteristics of males and females. The terms "gender" and "sex" are often used interchangeably. (Lewis, 2023)

When it comes to the military, discrimination is a common violation inside and outside unit walls. Discrimination in the military may be seen as an encouragement, even normalized. The military is a sector of severe gender segregation, both horizontal and vertical, since women are severely underrepresented in number (horizontal segregation) and at leadership positions (vertical or hierarchical segregation); for more on the topic of occupational discrimination. In Portugal, for example, the military went through meaningful changes regarding gender equality, ever since women joined the military as medical parachutists, all the way to today, where women represent 12% of the military (europarl.europa.eu, 2018).

2.2 Tokenism. "Gender Dynamics in a Masculine Professional Context: The Case of the Portuguese Air Force" by Maria Helena Santos is a study that introduces a new phenomenon in gender discrimination: *tokenism*. *Tokenism* is the practice of making a superficial or minimal effort to include members of marginalized or underrepresented groups to give the appearance of diversity or inclusivity, without actually addressing the underlying issues of equality or representation. It often involves symbolic gestures, such as hiring or promoting a small number of individuals from these groups, but without giving them real power, responsibilities, or opportunities for meaningful participation.

In many cases, tokenism can be harmful because it can reinforce stereotypes, lead to feelings of isolation or disempowerment for the individuals involved, and fail to create real structural change. Later on, we will recognize this phenomenon in individual declarations.

The generations we will be working with are the following: Gen X (1960-1980), Millennials/Gen Y (1981-1996) and Gen Z (1997-2012). The interviewees are representatives for both civilians and militaries of each generation previously mentioned, randomly chosen from the Lisbon Military Academy's personnel and citizens of Portugal.

2.2 Importance of study. This study's purpose is to be helpful in the process of raising awareness regarding gender discrimination in the military. As we may encounter future publications on this topic -such as a best-practices guide for the gender perspective of military personnel- they ought to be associated with mandatory modules on a gender perspective, so it is important to bring value to the following officers' training, to help them overcome challenges and improve their leadership skills. Gender perspective is an important matter when it comes to the contemporary point of view. Thus, the military is responsible for making sure it is always one step ahead.

2.3 About AI in the Military. An obvious example of how technological systems can incorporate and reinforce gender norms is the use of artificial intelligence in military applications. Identities react to circumstances that span local, national and international levels and align with race, ethnicity, age and ability. Gender norms and other social categories are not culturally constant. "Both gender and technology are products of a moving relational process, emerging from collective and individuals acts of interpretation", as Judy Wajcman explains. (Wajcman, 2021) As a result, technology and gender are influencing one another. AI is based on types of reasoning that are usually classified as masculine and are presented in both computing and warfare.

In the 1990s, feminist critiques of symbolic AI pointed out that the field was founded on an intelligence paradigm that separated the body from the mind. Logic and games are still given preference in modern attempts to mechanically reproduce human functions. For instance, "soft" intelligence — which is linked to feminine qualities like empathy, creative problem-solving, and persuasion—is sometimes contrasted with 'hard' intelligence. For instance, the majority of sex robots are shown as female and studies have shown that they may make gender-based violence worse. (Coughlan, Cave, & Dihal, 2019) The history of computation itself reflects these preconceptions of male dominance and female subservience: early coding was characterized as a secondary, derivative task, and the first computer programmers were women. Computer science, which is today recognized for changing society, just recently become a male-dominated profession. The connections between technology, masculinity, and superiority need not link them in this way, however. Gender based approaches to technology underline the importance of diversifying the people involved and expanding the framework of expertise. For military AI systems, this means assessing who is involved in their development, implementation, evaluation and regulation and then increasing gender parity. This does not just mean including more women engineers, computer scientists and military commanders in the process, although this is an important step. It also means recognizing a broader range of experts, including scholars of gender and identity, who can speak to the complexities and limitations of mimicking human processes through machine models. If AI is to replicate human intelligence, a narrow understanding of what is human must be replaced by a more complex model that includes the range of bodies, abilities and emotions that are all part of human experience.

2.4 Interview analysis. The research is based on a case study from Portugal, a country with progress in gender equality but persistent challenges in the military sector. According to the EIGE, Portugal, the country has a score of 61.3 out of 100, ranking 16th in the EU, with an increase of 7.6 points since 2010, indicating progress but also disparities. (EIGE, 2020)

The study uses semi-structured interviews with participants from Generation X (1965-1980), Millennials (1981-1996), and Generation Z (1997-2012) from Portugal, including both military and civilian personnel. The questions covered themes such as equality, institutional mindset, PR image, gender diversity, and stereotypes. Sample questions: "What does equality mean to you?", "How do you think the presence of women has changed the institutional mindset?", "What images come to mind when you think of women in the military?". Ethical considerations include confidentiality and informed consent, ensuring participants' anonymity. Thematic analysis was used to code responses, identifying patterns and variations. (González, 2014) However, the labor market shows gender segregation, and the military remains a predominantly male sector.

2.5 Interviews analysis method. For the analysis, I have used comparison, only to conclude the followings: this type of comparative analysis is crucial for understanding not only how men and women are perceived within the military environment, but also how external influences, such as the media and military advertising, affect their image and treatment within the armed forces. In the interviews conducted, participants were asked about essential concepts such as gender equality, institutional mindset, gender stereotypes, and the role of the media in creating a public image of women and men in the military.

The comparative analysis of the responses allowed for the identification of significant differences between the perspectives of civilians and military personnel, as well as the impact of women's representation in military advertising on social perceptions and gender discrimination within the military.

2.6 Interview responses. The interview responses showed notable differences in how civilians and military personnel understand and apply the concept of "gender equality." Military personnel were much more skeptical about the actual implementation of gender equality within the institution. Despite the presence of regulations supporting equal rights for men and women in the Portuguese military, most of the military personnel interviewed emphasized the existence of a "conservative institutional mindset" that does not actively promote the integration of women in leadership roles or combat units. In contrast, civilians had a more optimistic view of the progress made, considering that gender equality is a goal that should be achieved through active policy and continuous reforms. They pointed out that, although problems exist, there has been clear progress compared to the past, and examples from business and administration were often cited to support this view. While Portugal has a legal framework favorable to gender equality in the military, the resistance of institutional mindsets and conservative perceptions remains a significant barrier.

These mindsets are not always reflected in public discourse, suggesting that the implementation of changes is not happening at a fast enough pace. Another crucial point was related to the role of the media and military advertising in shaping perceptions about women in the military. Both civilians and military personnel agreed that the media plays a central role in building a positive image of women in the Portuguese military, but with the observation that this image is often idealized and unrealistic. Military advertising that features women in military uniforms is often used to embellish the image of the military and attract new recruits, but it does not reflect the everyday reality of women in the military, who face obstacles related to discrimination and stereotypes.

Military personnel mentioned that the image of the female soldier in military advertising is too uniform and does not reflect the diversity of roles women can have in the military. For example, women are often depicted in supporting or assisting roles, such as medical or administrative positions, and less in command roles or combat units. In contrast, civilians were more willing to acknowledge the potential for change in the media, being aware that such discourse can influence external perceptions of the military and help include women in more diverse roles.

The media and military advertising play a significant role in perpetuating stereotypical images of women in the military, reinforcing the idea that women should play secondary roles. This contributes to creating a distorted view of the roles of women in the military, which can affect their career progression and public perception of their competencies.

2.7 Militaries versus Civilians. Gender stereotypes are deeply rooted in the military, and interview responses highlighted that, in general, women are promoted less frequently than men, even when they have the same competencies. Military personnel emphasized that "women are often judged more harshly than men" regarding physical abilities and mental resilience, despite showing the same results. These stereotypes can limit women's advancement in their military careers and create a psychological barrier for those who wish to pursue a career in tougher fields, such as combat units or military aviation. On the other hand, civilians showed greater awareness of these stereotypes, considering them unfounded and discriminatory, emphasizing that there should be no differences between men and women in terms of promotion based on performance.

Gender stereotypes are a real barrier to women's career progression in the military, and the media contributes to maintaining these gendered images, creating unrealistic expectations about what women can achieve in the military. Both civilians and military personnel agreed that gender diversity is essential to creating a more balanced and realistic image of the military.

However, most participants noted that, at present, the Portuguese military does not reflect true diversity in its advertising, with images of men in leadership roles and women in subordinate roles being much more common. Gender diversity in military advertising is insufficiently promoted, which may perpetuate a model where women are viewed as being in supportive rather than leadership roles. Implementing campaigns that truly reflect the diversity of women's roles in the military could help reduce gender discrimination and stereotypes.

3. CONCLUSIONS & ACKNOLEDGMENT

3.1 Conclusions. The analysis of the interviews identified significant variations. Generation X showed a transition, with greater acceptance of women in operational roles, but still concerns related to physicality. Millennials were the most open, supporting equality but mentioning AI bias in recruitment as an issue. Generation Z highlighted the influence of media, considering that PR images can inspire confidence but may also perpetuate stereotypes.

The impact of AI was perceived differently: some participants mentioned risks of bias, such as voice systems that do not recognize female voices, affecting pilots, while others saw AI as a tool for monitoring gender policies. Comparatively, military personnel reported more direct experiences of discrimination, while civilians provided more theoretical perspectives. Younger generations, especially Millennials and Generation Z, appear to be driving the change, with more progressive attitudes, reflecting cultural shifts in Portugal. This aligns with the literature, suggesting an evolution towards equality. AI can be a tool for reducing discrimination by monitoring and analyzing data, but the risks include perpetuating bias through historical data. For example, 44% of biased AI systems have shown gender bias, according to UNIDIR, with implications for recruitment and military operations.

AI responses to searches can influence morale, providing biased information that may undermine trust. The media plays a significant role, with PR images often portraying women in non-combat roles, influencing public perceptions and recruitment. Participants mentioned that these images can inspire confidence but may also perpetuate stereotypes, affecting the morale of military personnel.

3.2 The analysis of the interviews with a focus on generations. Thanks to the comparison analysis, we can reveals distinct perspectives. Generation X showed a transition, with increased acceptance of women in the military but still expressed concerns related to physicality, with some responses like "I think women can be effective, but some roles are more suitable for men." Millennials, on the other hand, were very open and supportive of equality, but raised concerns about AI, noting that "AI systems might overlook women in recruitment." Generation Z, influenced by media, considered PR images to inspire confidence but also highlighted the risk of perpetuating stereotypes, with one participant saying, "I see women in advertisements as symbols of safety, but they don't reflect reality.". The media significantly influences public perception of women in the military, often reinforcing existing gender stereotypes by creating an idealized image that does not reflect the reality on the ground. Gender discrimination persists in the Portuguese military despite regulations favoring gender equality. This is largely due to a conservative institutional mindset that limits women's advancement to leadership and combat positions.

Military advertising plays a crucial role in shaping the image of women in the military, but it needs to become more diverse and realistic to reduce stereotypes and support genuine gender equality.

3.3 The impact of youth and education. Youth and education hold a critical role in transforming negative perceptions and challenging the stereotypes surrounding women in the military. By raising awareness about the importance of diversity and inclusivity, educational programs can help foster a more open-minded generation that is better equipped to question and dismantle outdated gender norms. These efforts can include promoting a deeper understanding of gender equality, emphasizing the value of diverse roles within the military, and ensuring that young people are exposed to more accurate and representative portrayals of women in the armed forces.

Furthermore, educational initiatives can encourage youth to critically engage with media representations, making them more discerning of the often idealized and stereotyped images of women in military contexts. Through the integration of these topics into school curricula, training sessions, and media literacy programs, young people can develop a greater appreciation for the complexities of gender equality.

The findings of this study emphasize the urgent need to shift entrenched institutional mindsets within the military, as well as the necessity of creating more authentic and diverse media representations. By aligning institutional policies with the evolving perspectives of younger generations and encouraging media that portrays women in a variety of roles—ranging from combat to leadership positions—the military can begin to challenge long-standing gender biases. This cultural shift, driven by both educational efforts and more responsible media portrayals, is essential for combating gender discrimination within military structures and fostering an environment where both men and women are treated equitably.

3.3 Future research directions. The limitations of this study include the sample size and the specific focus on Portugal, suggesting the need for comparative studies that examine gender equality across different countries and military contexts. The research is limited by the fact that it only reflects the perspectives of a small sample of individuals from a single national context, which may not fully capture the global complexities of gender dynamics within military institutions. Additionally, the findings may not be generalizable to other military forces with differing institutional cultures, policies, and societal norms regarding gender.

Future research could explore the impact of Artificial Intelligence (AI) in other military contexts, especially in countries with differing levels of gender equality and technological advancement. The role of AI in shaping recruitment, promotions, and operational roles could be examined in a broader set of military environments, with particular attention to how AI systems might perpetuate or reduce gender biases. Furthermore, it is important to consider how AI influences gender equality in the military through its potential to reinforce or disrupt institutional mindsets and gender stereotypes.

As a future research direction, I propose the development and consideration of a NATO manual or a set of best practices aimed at improving gender equality within military institutions. This could serve as a comprehensive framework for promoting gender balance in leadership roles, ensuring equal opportunities for both men and women, and challenging existing barriers related to gender bias. Additionally, I recommend the implementation of more workshops and awareness modules focused on gender discrimination, particularly addressing how these issues impact the morale and well-being of military personnel. Such programs could play a significant role in shifting mindsets, creating a more inclusive and supportive environment within the military.

Another important area for future research involves examining the ethical implications of using AI in military operations, particularly regarding how such technologies can influence gender dynamics within military structures.

Understanding how AI can be harnessed to promote or hinder gender equality will be crucial as technology continues to play an increasingly central role in modern military operations.

Lastly, partnerships and collaborations with other countries are beneficial for advancing this research. By comparing military institutions with differing levels of gender equality, the study can identify successful strategies and practices that can be adopted by other nations to improve gender inclusivity in their military forces.

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DIGITAL MODULATION TECHNIQUES: PRINCIPLES AND SOFTWARE-BASED SIMULATION ANALYSIS

Liliana-Maria VERES

Coordinator: Assist. Prof. Eng. **Constantin STRÎMBU,** PhD

"Henri Coanda" Air Force Academy, Brasov, Romania

Abstract: *Digital modulation of signals is a process through which digital symbols are transformed into waveforms compatible with the characteristics of the telecommunication channel over which they are to be transmitted. Telecommunications involve the transmission of various types of signals via communication channels, which may be either wired (using physical cabling: coaxial cable, fiber optics) or wireless. The latter includes satellite communications, television broadcasting, and wireless telephony. For example, phase-shift keying (PSK) and quadrature phase shift keying (QPSK) are commonly found in space communication systems. The aim of this paper is to present a method through which students can understand the concept of digital modulation by employing software that enables visualization of the signals involved in this process, as well as the resulting modulated signals. Additionally, this paper serves as a guide that highlights an alternative of using a conventional oscilloscope, specifically by utilizing the SIMULINK tool available in MATLAB's library. Therefore, this work outlines the advantages of employing this software as an educational instrument, emphasizing its numerous benefits in the teaching process, by allowing practical implementation of theoretical knowledge acquired during courses focusing on electrical signals and circuits.*

Keywords*: digital modulation techniques (ASK, FSK, PSK, QPSK) , spectrum efficiency, bandpass modulation, SIMULINK, electrical signals.*

1. INTRODUCTION

Modulation consists of altering a parameter of the carrier signal by the modulating signal that is to be transmitted, resulting in the frequency spectrum of the latter being shifted into the high-frequency domain. The information is transported between a radio equipment by modulating (modifying) a carrier signal. Modulation methods are of two types: analog and digital. The objective of the various available modulation techniques is to achieve spectrum efficiency; that is, to achieve a large amount of information within a given amount of bandwidth so as to make available the maximum number of channels within the bandwidth assigned to a service. Three fundamental analog techniques are used to modulate a carrier signal, each of which is applicable to one of the basic parameters of a sinusoidal signal: amplitude, frequency and instantaneous phase. (De Martino, 2012)

Angle modulation refers to modulation techniques in which either the frequency or the phase of a carrier signal is varied in accordance with a modulating signal. The carrier signal refers to the waveform being altered, while the modulating signal, contains the information that governs this alteration. Conventional analog modulation techniques, such as Amplitude Modulation (AM) and Frequency Modulation (FM), exhibit relatively low spectral efficiency. In contrast, Phase Modulation (PM), particularly in its digital implementations, offers significantly higher spectral efficiency.

As a result, digital PM techniques are preferred in modern communication systems. The transition from analog to digital modulation is progressing rapidly across both military and civilian sectors. This trend is driven by the superior spectral efficiency of digital modulation schemes, which enable more effective utilization of the limited Very High Frequency (VHF) and Ultra High Frequency (UHF) spectrum. Moreover, digital modulation improves overall system performance by allowing more reliable data transmission and better support for modern communication technologies.

2. UNDERSTANDING THE CONCEPT OF MODULATION: GENERAL ASPECTS

Modulation enables the efficient utilization of electromagnetic wave transmission systems and allows multiple signals to be transmitted over the same channel by employing time or frequency multiplexing techniques. The use of a communication channel is ruled by the access methods of the communication systems. There are two principal access methods and each takes its name from one characteristic of the communication waveform: Frequency-division multiple access (FDMA), in which the available frequency channels are divided among the users. Each user normally keeps the assigned channel until it needs to send messages and then it leaves it to a subsequent user; and Time-division multiple access (TDMA), in which the same channel is shared in time among many users. Switching among users happens so fast that the users do not perceive that the channel is shared. (De Martino, 2012)

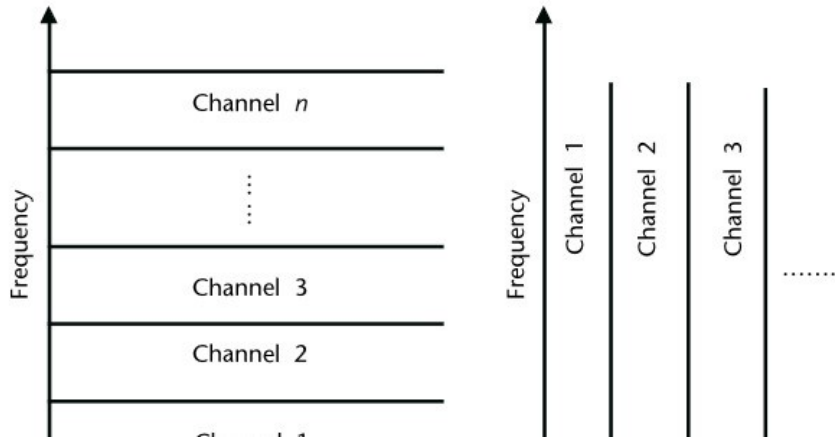

FIG.1 Principles of (a) FDMA and (b) TDMA access methods (De Martino, 2012:116)

In order to present the concept of modulation in a clear and accessible manner, it is essential to identify the signals involved in the modulation process, namely:

-the modulating signal, which contains the information or message to be transmitted;

-the carrier signal, onto which the information is transferred;

-the modulated signal, which results from the interaction between the modulating signal and the carrier signal, and is the signal actually transmitted.

In digital modulation, the modulating signal is a digital signal, consisting of a sequence of discrete bits or symbols that carry the information to be transmitted. This digital signal is imposed onto a carrier signal—typically a sinusoidal waveform—using various modulation techniques.

In analog modulation, the modulating signal is an analog signal—a continuous-time signal that can take on a wide range of amplitude values.

It typically represents information such as voice, music, or other naturally varying signals, and it is used to vary a property of the carrier wave (amplitude, frequency, or phase) in a continuous manner.

Digital modulation is generally considered better because it offers greater noise immunity, meaning it is more resistant to signal degradation caused by interference and transmission errors—ensuring more reliable and accurate data communication. Two main types of digital transmission can be distinguished: baseband modulation, typically used for short-distance transmissions, and bandpass modulation, which is suited for long-distance and wireless communications. Baseband modulation involves the direct transmission of digital signals without the use of a carrier, typically employed in short-distance, wired communication systems. Bandpass modulation, on the other hand, modulates a carrier signal with digital information, making it suitable for long-distance and wireless transmission environments. Also referred to as carrier modulation, this technique involves encoding digital information by altering the parameters of a high-frequency sinusoidal signal, known as the carrier. A sinusoidal waveform is defined by three fundamental parameters: amplitude, frequency, and phase. Accordingly, the three primary forms of bandpass digital modulation are amplitude shift keying (ASK), frequency shift keying (FSK), and phase shift keying (PSK).

3. FUNDAMENTAL DIGITAL MODULATION TECHNIQUES AND MATLAB-BASED PRACTICAL EXAMPLES

This section of the paper aims to present the theoretical concepts of the three fundamental types of modulation, followed by practical implementations developed in MATLAB to demonstrate the performance and outcomes associated with each technique. To illustrate the modulation process as clearly and rigorously as possible, I used the SIMULINK environment. This platform enabled the integration of various functional blocks to construct the modulation architectures, as well as to visualize critical components such as the input bit stream, the carrier signal, and the resulting modulated waveform. For each of the three modulation types, schematic representations of the simulation models will be provided, alongside screenshots captured using the Scope block from the MATLAB Simulink library. These visual outputs correspond to specific signal paths within the system and were employed to analyze both the intermediate signals involved in modulation and the final modulated output.

3.1 Amplitude Shift Keying (ASK). In ASK, a carrier burst is transmitted for each binary symbol ‘1’, while no signal is transmitted for symbol ‘0’. It is a form of modulation that represents digital data as variations in the amplitude of a carrier wave. The amplitude of an analog carrier signal varies in accordance with the bit stream (modulating signal), keeping frequency and phase constant. This digital modulation scheme is used to transmit digital data over optical fiber, point to point military communication applications, etc. The combination with PSK yields derivatives like QAM (Quadrature Amplitude Modulation), which have much important application with improved parameters. (Channi, 2016)

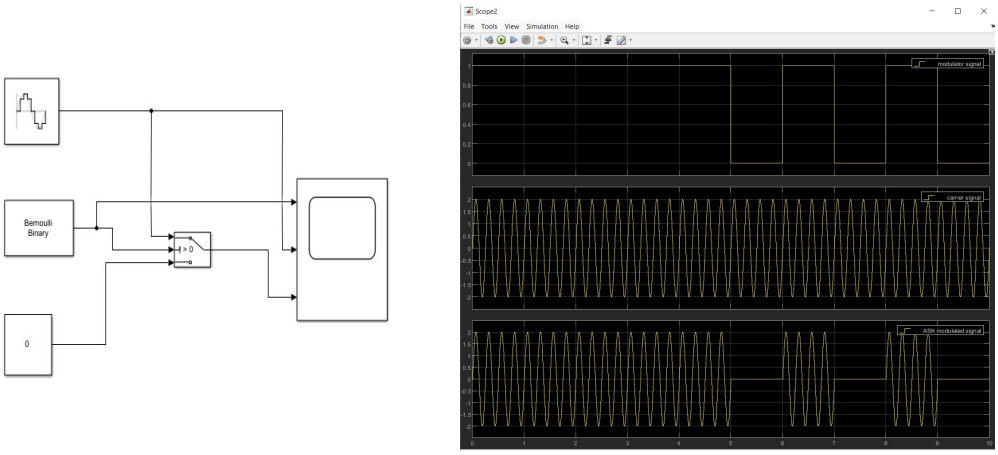

FIG.2 SIMULINK configuration of ASK and modulation result

3.2 Frequency Shift Keying (FSK). In FSK, binary data is represented by variations in the carrier frequency. Typically, one frequency is used to represent a symbol '1' and another for a symbol '0'. FSK is recognized as one of the earliest digital modulation techniques applied in practical communication systems. It is a frequency modulation scheme in which digital information is transmitted through discrete frequency changes of a carrier wave. The simplest FSK is binary FSK (BFSK). BFSK literally implies using a couple of discrete frequencies to transmit binary (0s and 1s) information. With this scheme, the "1" is called the mark frequency and the "0" is called the space frequency. Minimum frequency-shift keying or minimum-shift keying (MSK) is a particular spectrally efficient form of coherent FSK. In MSK, the difference between the higher and lower frequency is identical to half the bit rate. Audio frequency-shift keying (AFSK) is a modulation technique by which digital data is represented by changes in the frequency (pitch) of an audio tone, yielding an encoded signal suitable for transmission via radio or telephone. Normally, the transmitted audio alternates between two tones: one, the "mark", represents a binary one; the other, the "space", represents a binary zero. AFSK differs from regular frequency-shift keying in performing the modulation at baseband frequencies. AFSK is not always used for high-speed data communications, since it is far less efficient in both power and bandwidth than most other modulation modes. (Channi, 2016)

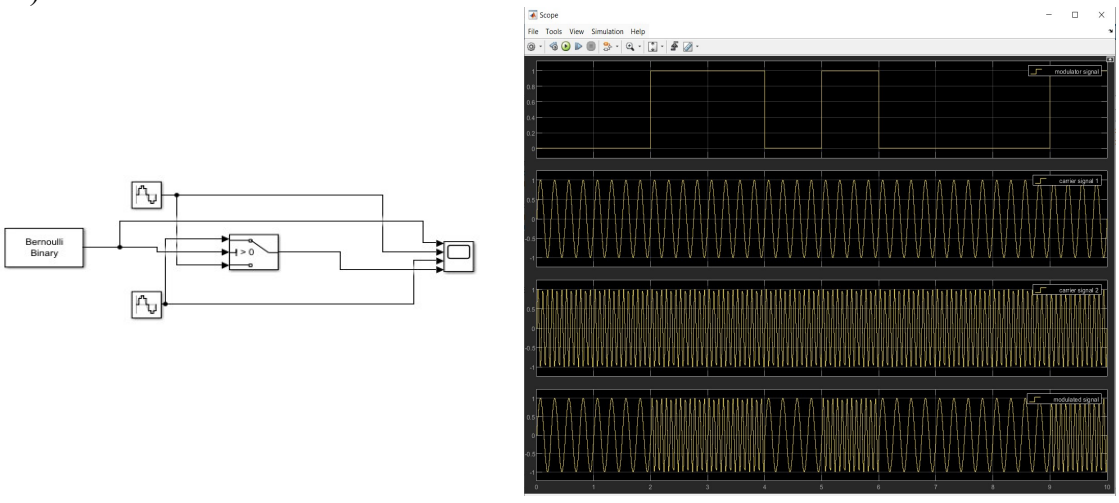

FIG. 3 SIMULINK configuration of BFSK and modulation result

3.3 PHASE SHIFT KEYING (PSK). PSK constitutes a broader category of modulation schemes and is widely utilized in modern digital communication, due to its high spectral efficiency and power efficiency. In its binary form (BPSK), a symbol '1' is conveyed using a carrier with an initial phase of 0°, while a symbol '0' corresponds to a 180° phase shift. Compared to ASK and FSK, PSK offers better bandwidth utilization and improved noise resilience, contributing to its widespread adoption. Nonetheless, ASK and FSK remain relevant in applications where low-complexity implementation is prioritized.

The simplest form of phase shift keying (PSK) is binary phase shift keying (BPSK). It uses two phases which are separated by 180° and so can also be termed 2-PSK.(Channi, 2016)

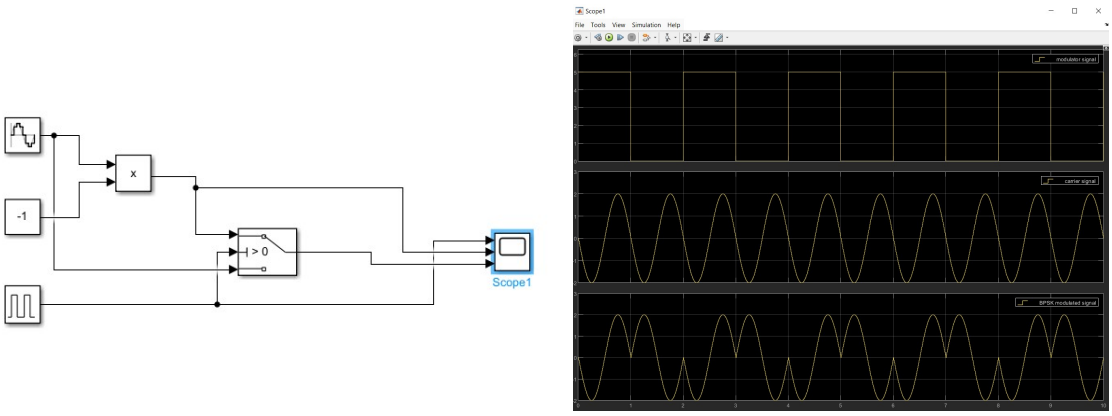

FIG.4 SIMULINK configuration of BPSK and modulation result

4. DEVELOPMENT OF A MATLAB MODEL FOR SIMULATING QPSK MODULATION

Building upon these fundamental techniques, more advanced modulation schemes can be derived. For instance, quadrature phase shift keying (QPSK) is formed by combining two orthogonal BPSK signals, thereby doubling the data rate without increasing bandwidth.

In the Quadrature Phase Shift Keying (QPSK) digital modulation scheme, the phase of the carrier signal is divided into four equally spaced angles: π/4, 3π/4, 5π/4, and 7π/4. This configuration allows QPSK to convey twice as much information as Binary Phase Shift Keying (BPSK), representing a significant advantage in terms of data transmission efficiency.

BITS	PHASE (rad)
11	π/4
01	3π/4
00	5π/4
10	7π/4

FIG.5 Correspondence between bit pair and the carrier phase

The QPSK becomes a highly bandwidth efficient digital modulation technique because in its constellation diagram (figure 6), there are four message points. The data

bits to be transmitted are combined into symbol, each containing two bits. Each symbol can take on one of four possible values which are 00, 01, 10 or 11. The bandwidth requisite and power requirement is less because more data can be transmitted using different phases and single carrier QPSK technique may be used either to double the data rate, compared to a BPSK modulation system, while maintaining the bandwidth of the signal, or to maintain the data rate of BPSK, but half the bandwidth requirement.

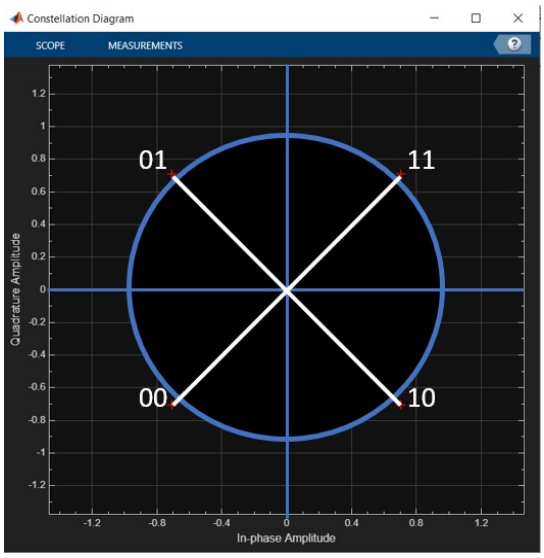

FIG.6 Constellation diagram

In Quadrature Phase Shift Keying (QPSK)**,** the constellation diagram is a fundamental tool used to represent the modulation scheme in the complex plane. It visually illustrates the mapping between digital bit combinations and corresponding signal waveforms in terms of their phase and amplitude characteristics.

Following the methodology applied to the basic modulation schemes (ASK, FSK, and BPSK), this section addresses a more complex modulation technique, namely Quadrature Phase Shift Keying (QPSK). Figures 7 and 8 present the simulation setup and results: the first illustrates the QPSK modulation model built using dedicated Simulink blocks; the subsequent images show the output of the Scope block, including the sinusoidal carrier signal, two rectangular waveforms used to generate bit combinations, and the resulting QPSK-modulated signal.

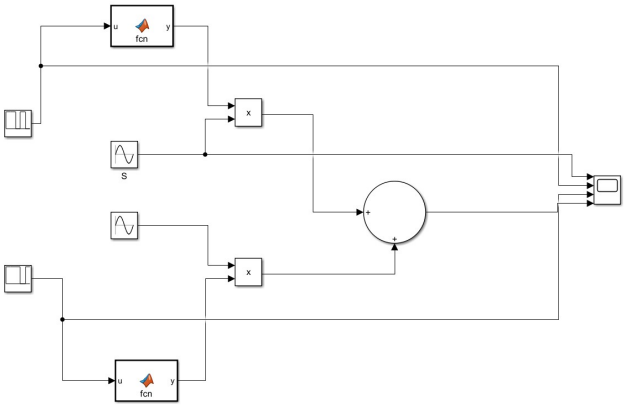

FIG.7 SIMULINK configuration of QPSK

It should be noted that the research will be further supported by a live demonstration during the project presentation, where each functional block used in the simulation model will be explained in detail. The MATLAB/Simulink models will be executed in real time to showcase the operation of the modulation schemes. These additional explanations, in conjunction with the theoretical framework provided in the paper, aim to offer a complete and balanced understanding of the digital modulation process.

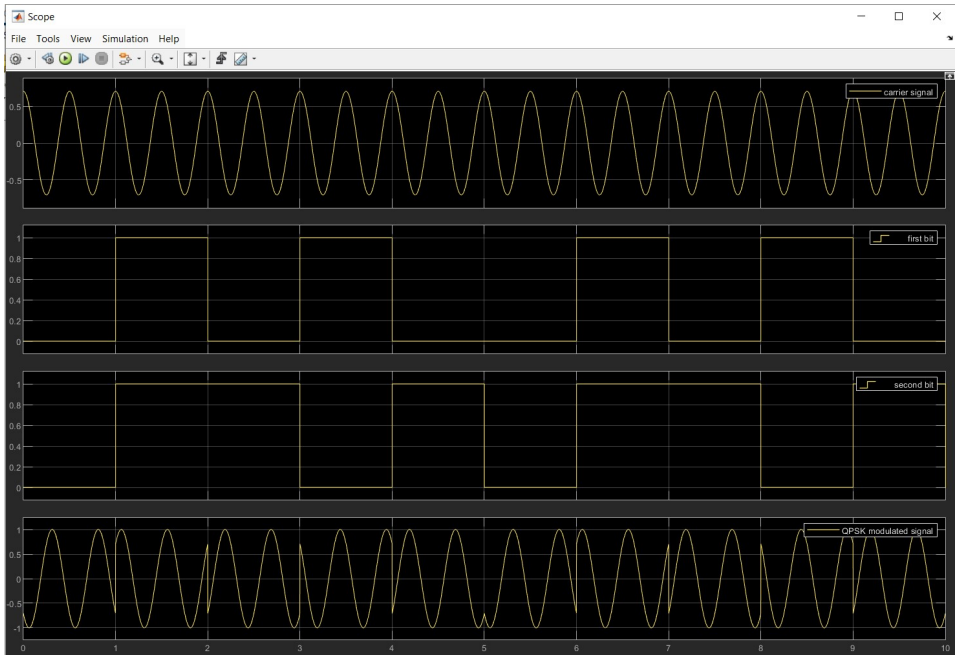

FIG.8 Modulation result

5. FUTURE WORK

Digital modulation remains a fundamental area within the field of modern communications, offering numerous opportunities for further exploration. A natural extension of the present research would be the implementation and analysis of more complex modulation schemes, such as Quadrature Amplitude Modulation (QAM), using the same MATLAB/Simulink simulation environment. This would enable a broader understanding of spectral efficiency, signal quality, and robustness in more advanced digital modulation contexts. Such future work aims to emphasize the importance of applying theoretical concepts through practical simulation tools that promote experiential learning. The integration of platforms like MATLAB not only aids in the conceptual understanding of modulation techniques, but also fosters the development of essential practical skills for students pursuing technical specializations. Through these tools, learners are able to simulate, visualize, and critically analyze signal behavior, thereby bridging the gap between abstract theory and real-world applications. By expanding the scope of the study to include more sophisticated schemes like QAM, future research will contribute to a more comprehensive understanding of digital communication systems and further highlight the educational value of simulation-based methodologies in technical education.

6. CONCLUSIONS

This paper has explored both the theoretical foundations and practical implementation of digital signal modulation. Core concepts related to the modulation process were thoroughly examined, while their applicability was demonstrated through simulation-based modeling using MATLAB and its Simulink interface. This environment facilitated the construction of signal modulation schemes and enabled the visualization and analysis of the resulting waveforms, thus allowing for the validation of theoretical knowledge through practical experimentation. Given the central role of digital modulation in modern military communication systems, acquiring a deep understanding of these techniques is essential for students pursuing technical military education, as they will be responsible for operating advanced communication platforms. In this regard, the study achieves its intended purpose—bridging theory and practice—and provides a clear and applied understanding of digital modulation through structured examples.

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STUDY ON ELECTROMAGNETIC WAVE PROPAGATION IN WATER FOR WIRELESS CHARGING OF UNDERWATER DRONES

Ovidiu-Andrei BOALCA

Coordinator: Assist. Prof. Eng. **Vlad MOCANU**, PhD

"Mircea cel Batran" Naval Academy, Constanta, Romania

Abstract: *This paper investigates the feasibility and performance of underwater wireless power transfer (WPT) systems for autonomous underwater vehicles (AUVs). As AUV operations expand in scope and duration, the need for efficient, contactless energy delivery becomes increasingly critical. Traditional charging methods rely on physical connectors, which are prone to wear, corrosion, and alignment issues in submerged conditions. WPT presents a promising alternative, offering more flexible and durable recharging capabilities. Seawater's electrical properties—such as conductivity, salinity, and permittivity—play a significant role in how electromagnetic waves propagate through the medium. These parameters directly affect signal attenuation and transmission efficiency, especially at higher frequencies where energy is rapidly absorbed. For this reason, low-frequency magnetic fields are often more effective for underwater applications, as they experience less attenuation and can penetrate further into conductive environments. To assess these challenges and opportunities, this study uses simulation models developed in ANSYS Maxwell. The models include various coil geometries and operating frequencies, allowing for the analysis of how alignment, transmission distance, and material properties affect WPT efficiency. Results confirm that optimal performance is achieved at lower frequencies, with precise coil positioning being essential to minimize energy losses. Ultimately, this research provides design insights for engineers developing underwater WPT systems. Key factors such as frequency selection, coil configuration, and environmental conditions must be carefully balanced to ensure reliable energy delivery to submerged platforms like AUVs.*

Keywords: *wireless power transfer; underwater vehicles; magnetic field propagation; seawater conductivity; low-frequency transmission*

1. INTRODUCTION

With the growing use of autonomous underwater vehicles (AUVs) in oceanographic research, offshore industries, and defense operations, ensuring a continuous and reliable energy supply has become a major engineering concern. These vehicles are often deployed for extended missions, where returning to a base station for manual recharging is inefficient or impractical. Traditional wired charging methods, while straightforward on land, require physical contact, precise alignment, and are susceptible to corrosion and mechanical failure when used in submerged environments.

Wireless power transfer (WPT) offers a promising alternative by enabling contactless energy transmission, reducing maintenance demands and allowing for fully autonomous operation. Through inductive or resonant coupling, WPT systems can deliver power efficiently over short distances without physical connectors, which is especially beneficial in underwater settings where mechanical docking is challenging.

However, the marine environment presents unique constraints that complicate the deployment of WPT. Seawater is a conductive medium with high salinity and permittivity, which significantly influence the propagation of electromagnetic fields. These properties can lead to increased attenuation, especially at higher frequencies, limiting the effective range and efficiency of wireless systems.

This study focuses on the behavior of electromagnetic waves—particularly low-frequency magnetic fields—as they propagate through seawater. Using simulation-based analysis, several WPT configurations are evaluated in terms of performance, efficiency, and adaptability. The objective is to identify design principles that can enhance the feasibility of underwater WPT, providing reliable energy solutions for next-generation autonomous platforms.

2. ANALYSIS OF ELECTROMAGNETIC WPT PERFORMANCE IN MARINE ENVIRONMENTS

Wireless power transfer (WPT) in underwater environments presents a complex engineering challenge due to the unique electromagnetic properties of seawater. High conductivity and permittivity contribute to significant attenuation of electromagnetic waves, especially at higher frequencies. Therefore, understanding how electromagnetic fields behave in such media is critical for designing systems capable of efficiently delivering power to submerged platforms, such as autonomous underwater vehicles (AUVs). This section presents an in-depth analysis of WPT system performance in marine conditions, focusing on electromagnetic field propagation, material interactions, and environmental constraints.

The analysis is supported by finite element simulations and comparisons with established research in the field. Parameters such as transmission frequency, coil geometry, alignment, and distance are investigated to quantify their effects on energy transfer efficiency. The insights derived from these simulations form the basis for developing optimized WPT systems tailored to underwater applications. By aligning theoretical knowledge with practical engineering design, this study aims to provide actionable recommendations for enhancing the robustness and reliability of underwater wireless charging technologies.

2.1 Electromagnetic Behavior in Conductive Environments

Seawater is a highly conductive medium, and this characteristic has a significant impact on the propagation of electromagnetic waves. Due to its ionic composition, the medium imposes strong attenuation on electric fields, which are absorbed quickly and cannot travel far. In contrast, low-frequency magnetic fields are much less affected by conductivity and are therefore able to propagate more effectively over short distances. This behavior makes **magnetic induction** the most appropriate and reliable method for implementing wireless power transfer (WPT) in underwater environments.

A critical concept in understanding this propagation behavior is the **skin depth**, which represents the distance at which the amplitude of an electromagnetic field decays to about 37% of its original value due to the conductive nature of the medium. In the case of seawater, the skin depth at a frequency of 100 kHz is approximately 25 centimeters. This level of penetration is generally sufficient for close-range energy transfer, such as in docking stations, tethered recovery systems, or shallow deployments of AUVs. However, as the transmission frequency increases, the skin depth decreases exponentially, leading to much higher energy losses through resistive dissipation.

This frequency-dependent limitation imposes a strong constraint on the design of underwater WPT systems, favoring low-frequency operation in order to maintain practical levels of efficiency. Consequently, coil systems and resonant circuits must be optimized not only for performance but also for compatibility with the electromagnetic behavior of seawater at these frequencies.

2.2 Simulation Environment and Parameters

To evaluate different coil and transmission scenarios, finite element simulations were conducted using **ANSYS Maxwell**. The simulated models included circular and rectangular coils with varying diameters, number of turns, spacing, and core materials (ferrite and air core). The operating frequency was varied from 10 kHz to 1 MHz to observe performance across the practical spectrum.

The seawater environment was simulated with a conductivity of 4 S/m, typical for ocean conditions. Efficiency was calculated as the power received at the load versus the power transmitted, under different distances (5–20 cm) and alignments.

Table 1. Coil Design vs. Transfer Efficiency in Seawater (200 kHz)

Coil Type	Core Material	Distance (cm)	Alignment	Efficiency (%)
Circular (10-turn)	Ferrite	10	Aligned	72.4
Rectangular	Air core	10	Aligned	45.1
Spiral planar	Ferrite	15	Misaligned	28.7

The results show that **circular ferrite-core coils**, aligned at short distances, provide the highest efficiency. Efficiency drops considerably when misalignment occurs or distance increases, demonstrating the importance of careful mechanical and magnetic design.

2.3 Coil Design and Frequency Considerations

Frequency plays a crucial role in underwater WPT. Lower frequencies (under 500 kHz) reduce eddy current losses in the medium, but increase the size of resonant coils due to larger inductance and capacitance requirements. There is a balance between system size, efficiency, and practicality.

Coil design must also account for the **mutual inductance** between transmitter and receiver. Using ferrite cores increases magnetic coupling and reduces stray field loss. Multi-turn configurations further enhance magnetic field strength, though they also introduce parasitic resistance, which must be minimized through high-conductivity wiring and compact layouts.

Additionally, **coil misalignment**—whether lateral, angular, or axial—has a profound impact on performance. Simulations confirmed that even a 5° tilt or 3 cm lateral offset could reduce efficiency by 30–50%. Therefore, mechanical stabilization or automatic repositioning mechanisms are vital in mobile underwater platforms.

2.4 Literature Insights and Design Guidelines

Existing literature provides strong foundational support for the approaches discussed. Ryou et al. (2016) demonstrated the feasibility of magnetic resonance in underwater charging scenarios, recommending low-kilohertz operation and close-range transmission. Kiani et al. (2019) introduced shielding techniques to concentrate magnetic fields and limit energy loss, which proved especially useful in layered environments. Yamaguchi et al. (2023) modeled integrated EM-circuit systems and showed the importance of simultaneous field and circuit optimization in marine applications.

From the literature and simulation data, the following guidelines are recommended:

- Operate WPT systems in the range of 10–500 kHz.

- Use ferrite-core circular coils with at least 8–10 turns.
- Maintain transmission distances under 15 cm for practical applications.
- Integrate magnetic shielding and alignment correction systems.
- Avoid planar coil geometries unless space constraints are critical.

These guidelines serve as a foundation for building robust underwater energy systems capable of supporting long-duration and autonomous underwater missions.

3. CONCLUSIONS

This study explored the use of electromagnetic wave propagation—particularly low-frequency magnetic fields—for wireless power transfer in underwater environments. Through numerical simulations and a critical review of existing research, it was shown that efficient power transmission is achievable using carefully designed WPT systems that account for environmental and geometric constraints.

Key findings include the superiority of ferrite-core circular coils, the importance of alignment, and the effectiveness of operating at lower frequencies to mitigate seawater attenuation. The integration of magnetic shielding and feedback-based alignment systems is essential for achieving reliable underwater charging.

These results contribute to the advancement of autonomous underwater robotics by offering viable, cable-free energy transfer solutions. Future research should focus on experimental validation of the proposed designs in open-sea trials and the development of adaptive coil systems for dynamic underwater conditions.

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SIMULATION OF A MILITARY RADAR DISPLAY SYSTEM USING UNREAL ENGINE

Melina IFTIME

Coordinator: Assoc. Prof. Eng. **Liliana MIRON**, PhD

"Henri Coandă" Air Force Academy, Braşov, România

Abstract: *With this presentation, I am pleased to focus on the simulation of a military radar display system using Unreal Engine, aiming to create an interactive and realistic environment for testing, training, and algorithm development. The simulation provides a reliable testing environment that allows the evaluation of radar behavior under diverse operational conditions. By leveraging Unreal Engine's capabilities—such as dynamic lighting, detailed textures, and visual effects—it becomes possible to recreate complex target detection scenarios that contribute to the realism of the simulation. The virtual radar model facilitates performance evaluation by enabling the adjustment of key parameters like detection range, scanning angle, and target type. This allows for comprehensive testing of the radar's responses, aiding in the improvement of detection algorithms. Moreover, integration with control and monitoring systems enables real-time visualization of target movements, identification, and display of critical data such as distance, speed, and direction, all within an intuitive user interface.*

Keywords: *simulation; radar; detection; user interface.*

1. INTRODUCTION

The advancement of real-time simulation technologies has opened new possibilities for developing and testing complex military systems in virtual environments. One such application is the simulation of military radar systems using powerful platforms like Unreal Engine. This approach allows the creation of highly interactive and realistic visual experiences, essential for understanding and analyzing radar behavior in tactical and operational contexts.

Unreal Engine provides the tools necessary to implement a near-real visual representation of radar operations, including holographic 3D environments, scanning effects, and real-time distance measurements. These elements help users to better grasp the functionality and tactical significance of radar systems.

2. AIMS OF THE RADAR SIMULATION

2.1 The Idea of Simulation

Simulation is the process in which a system, or behavior is created or replicated in a controlled environment in order to understand, test or forecast the demeanor of its real counterpart. In the technological context of modern applications, simulation is used to reproduce specific operating conditions, usually through a software, to analyze performance, evaluate scenarios and test hypotheses without the need to implement a physical system.

Regarding the development of radar systems, UE applications, the concept of simulations becomes a "pillar" for testing and validation of certain usage scenarios in safe and controlled environments.

Simulations are fundamental for a radar system's performance validation and improvement, before its real-world implementation. Some advantages of radar simulation in UE are:

- Speed and flexibility, as Unreal Engine allows for fast creation and continuous testing of simulations, without the need to recompile the code, or to modify the physical hardware, facilitating rapid development cycles, allowing for instantaneous modifications and adjustments to the radar's scenarios.
- Realistic visuals, as UE permits the creation of extremely realistic 3D renders including lighting effects, reflections and shadows, essential for a radar's true operational environment simulation.
- Complexity of various environmental scenarios (such as bad weather, rough terrain, dim light), that would be difficult and/or expensive to replicate in real-life, granting the upgrade of radar technology.
- Real-time interaction, allowing the users to modify radar parameters on the fly and see the impact of said parameters to its performance, facilitating the quick testing of different settings and functioning conditions.

2.2 Introduction to Unreal Engine Platform

In order to conduct this case study, I have used Unreal Engine (UE), a 3D graphical engine developed by Epic Games, with its first version made public in 1998. This engine is used mainly for video games, virtual and augmented reality (VR/AR) interactive applications production. UE offers extremely powerful graphics, being capable of delivering high quality real-time visual effects, including realistic shadows and sceneries.

The ground-breaking ray-tracing technology implemented in the graphical engine facilitates realistic lighting effects such as reflections, path-traced lighting and dynamic illumination.

A concept that became very popular through this platform is the visual programming using Blueprints. This concept enables the developers to construct the logics behind games and application without the use of code. Blueprints offer maximum flexibility, because designers can create variables, functions and events in a visual format, without the knowledge of traditional programming. This workflow allows the developers to conceive and test directly in the editor, without the need to recompile the project, thus ensuring a faster and more efficient development process.

3. RADAR IMPLEMENTATION

The construction of the radar is implemented through Blueprint logic nodes. After we have been installing the application from Epic Games's platform, version 4.27 for it to be compatible, subsequent to the case study of my own degree using HoloLens 2.

1st step: After installation, I have accessed the "Games" tab, and selected the creation of a "Blank" project. This is a base project, with no predetermined content, which can be used as a starting point for creating applications and simulations. Such a project is ideal when we want to have total control over the resources, functionalities and scenarios that we are going to implement without being influenced by predefined templates or structures.

2nd step: The project was named in the application's settings, in the cell name "Project Name", and the project was saved in one of the PC's partitions after we had been decided what operating mode we want to create the project (C++ or Blueprints).

FIG. 1 Details for project implementation

3rd step: We accessed the "Create Project" button. We named it "WorldBuilder".

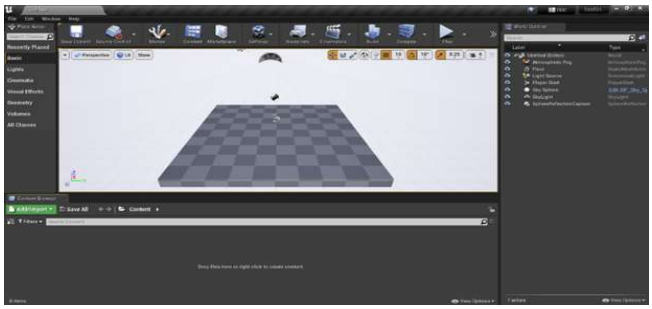

FIG. 2 Initial working window

4th step: I worked on the environment that will integrate the map. I created a folder named "Environment" to maintain an organized workflow. After removing the light source and everything that composed the support of the objects, a blank canvas on which we will simulate targets and the radar projection in 3D is all that is left.

5th step: I created the radar's base, naming it "2D_Radar_BP", after which I referenced it through "Parent Actor", giving it the ability to control other components as well. I named actor "Full_Radar_2D", ensuing its processing in "Event Graph". "Event Graph" is a visual graph used in blueprints to add game logics and to manipulate actors' and other objects' behavior within the game.

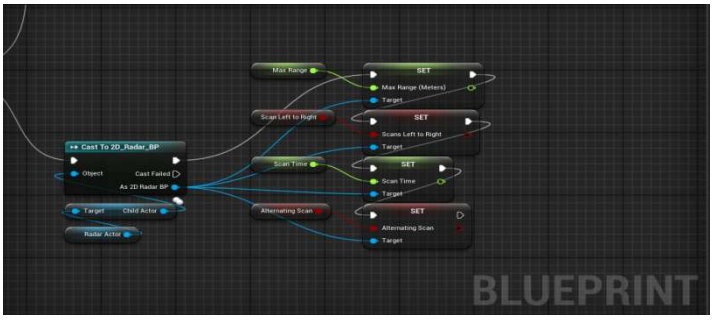

FIG. 3 The logic behind nodes

6th step: After we have finished connecting the nodes for the functioning part of the radar ("Parent"), we turn our attention towards displaying the targets on certain interfaces, known here as "Widget". The image we created to frame the radar has been developed by adding a "User Interface", option that allowed us to create a display on our own.

7th step: I started by adding a "Canvas Panel", which created the border of the image. Inside I inserted an option called "Image", which I named "Radar Display".

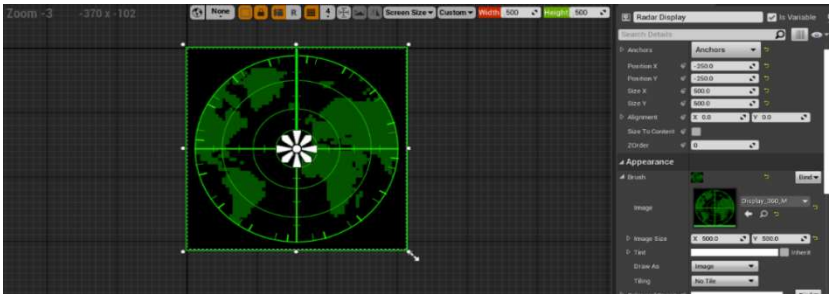

FIG. 4 Radar Display

8th step: After configuring the display and scanner, the radar's widget is finished. Now we move to creating the future target's widgets. We created two types of targets so we can differentiate them on the radar.

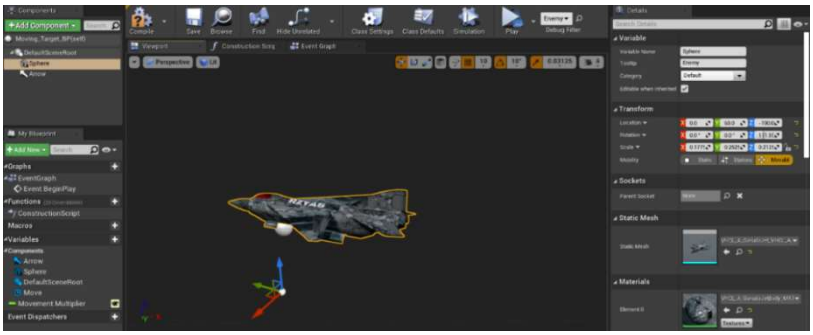

FIG. 5 Target editing

4. CONCLUSION

I have implemented the last modifications of the "2D_Radar_BP" blueprint, representing in fact the mechanism that dictates the behavior of the radar. I pressed "Play" to run the game, the result being a positive one. The aircrafts in the outer field are moving, as specified by us through the nodes, meanwhile, friendly and enemy targets are shown on the radar's display, in their related colors, as the scanner moves as programmed. The implementation also allowed for real-time visualization, which is essential for both training and system validation. Overall, the project provides a valuable tool for testing radar functionalities in a controlled, risk-free virtual environment, and lays the groundwork for future enhancements such as Doppler analysis, clutter filtering, and integration with AI-based target classification.

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THE REVOLUTION IN AIR WARFARE IN THE INTERWAR PERIOD AND THE EARLY STAGES OF THE SECOND WORLD WAR

Radu Andrei JUGĂNARU

Coordinator: Cdor (r) Lect. **Jănel TĂNASE**, PhD

"Henri Coanda" Air Force Academy, Brasov, Romania

Abstract: *Aviation in World War II played a key role not only in the initial successes of the Wehrmacht but also in shaping the evolution of modern warfare. The Luftwaffe, Nazi Germany's air force, was among the most advanced in the world at the beginning of the conflict. It played a crucial role in the Blitzkrieg strategy, which combined rapid tank and infantry assaults with precise air strikes. This high level of coordination highlighted the importance of integrating air power into combined military operations.*

Beyond its tactical role, the Luftwaffe aimed to achieve air superiority—a relatively new concept at the time, but one that proved essential for controlling the battlefield. Its dominance was clearly demonstrated during the campaigns in Poland, France, and the early stages of the Eastern Front.

This project explores how German aviation developed both as an institution and as a powerful military force. It also examines how close coordination with ground forces reshaped the modern warfare. The Luftwaffe showcased the devastating potential of air power, making other nations to rethink their military doctrines and cementing aviation as a vital component of modern combat.

Through an analysis of the Luftwaffe's evolving tactics, technologies and strategic impact, this project aims to reveal how German air power influenced the course of early stages of World War II and left a lasting legacy on modern military doctrine.

Keywords*: Luftwaffe, Blitzkrieg**, aviation, tactics, war*

1. INTRODUCTION

After the end of the Great War, rapid advancements in aviation technology transformed the nature of warfare, prompting military theorists to reconsider traditional doctrines. Among the most influential figures in this emerging field was the Italian general Giulio Douhet. His groundbreaking work, *The Command of the Air* (1921), laid the foundation for modern strategic bombing doctrines and introduced a revolution in military thinking. He „was instrumental in organizing an independent Italian air force„ (Addington,1994:185).

With the terrible memories of trench warfare, military strategists across Europe searched for new ways to prevent the stagnant, attritional conflict that had defined the Western Front. Thus, the appearance of the aircraft on the battlefield gave theorists a glimpse into a new dimension of combat. Douhet recognized the potential of air power to bypass traditional battlefield stalemates "therefore, the rapid, terrifying and violent attack, was essentially directed at the most vulnerable parts in order to end the war with minimum losses" (Aeronautica, Revista subsecretariatului de stat al aerului, 1936:32)

In his work, Douhet came up with innovative ideas like air superiority, strategic bombing, and the cooperation between military branches. He was certain that the Air Force would become the leading force in future conflicts: "The armed forces form a unified and indivisible entity, therefore, the three branches of the military must be coordinated in such a manner as to achieve the highest possible efficiency through their collaboration" (Aeronautica, Revista subsecretariatului de stat al aerului, 1936:13)

First of all, one of the most critical aspects of the new warfare was total air supremacy. Douhet argued that once a nation controlled the skies, it could launch massive bombing campaigns against enemy cities, factories, and logistical networks. His key point in gaining air supremacy was a surprise and decisive attack against enemy aircraft while they were still on the ground. By doing so, the enemy air force would be paralyzed and, soon enough, it would be eliminated, leaving allied planes free to operate within enemy territory.

Moreover, the air force should be flexible enough to move from one base to another very efficiently. Not only that, but after gaining air supremacy, Douhet pointed to the importance of bombing the enemy into submission by striking important city centers that would cause social and economic collapse, demoralize civilian populations and force governments to capitulate.

Douhet's ideas had a profound impact on military planning in the decades that followed. His work influenced air power doctrines in major nations, particularly the United States, the United Kingdom, and Germany, during the interwar period and World War II.

2. THE BIRTH OF THE LUFTWAFFE

After the First World War, Germany was subjected to the Treaty of Versailles, which imposed severe military restrictions aimed at preventing future aggression. By the early 1930s, Germany lacked a capable air force, as ,,The Germans faced considerable difficulties in the creation of an air capability with the onset of rearmament in 1933,, (Murray, 1983: 3).

Nevertheless, Germany had a strategic advantage in the form of a secret agreement with the Soviet Union, which allowed German engineers to design and test aircraft at the Lipetsk airfield. ,,Until 1933, Germany got around prohibitions in the Treaty of Versailles on air forces to a degree by exchanging technical knowledge on aircraft with Soviet Russia in return for the use of an airfield near Lipetsk,, (Addington, 1994:186).

At this site, German pilots were trained using fighter aircraft such as the Fokker D.XIII and reconnaissance planes like the Heinkel HD 17. Domestically, the state of the air forces was dire, as no aviation institution had survived the aftermath of the First World War: ,,Given the fact that no German air force survived from the Great War,, (Murray, 1983: 3).

One trick employed by the Germans involved the establishment of civil aviation schools, such as the Civil Aviation Pilot Training Center (Deutsche Verkehrsflieger - Schule), which were officially designated for training personnel for future Deutsche Luft Hansa airlines, but in practice served to prepare military pilots.,,the pilots and ground crews of Lufthansa had the skills which could be applied to military aviation,, (Addington, 1994:186).

In 1933, the German Air Ministry was established, with Hermann Göring, Hitler's close friend, appointed as its head. ,,Göring created the upper echelons of the Luftwaffe by transferring officers from the army and the navy to the new air force, and by commissioning civilian aviators,, (Addington, 1994:186).

The Luftwaffe was officially recognized and publicly established on February 26, 1935. As a result, the first official military aviation manuals were created: „When Hitler began rebuilding the Luftwaffe during the mid-1930s, these ideas were reflected in its first operations manual (1935), entitled Die Luftkriegführung - literally, 'The Conduct of Air Warfare„ (Van Creveld et al.,1994:28). This marked the beginning of integrated operations among military branches:„those forces could only be defeated by the combined action of all three services„ (Van Creveld et al.,1994:28).

At the same time, Luftwaffe doctrine introduced the notions of air superiority, operational effectiveness, large-unit maneuvering from division to army group level, and direct support of ground forces. This support was categorized into "unmittelbar" – direct- and "mittelbar" – indirect- (Van Creveld et al.,1994:28). General Walther Wever argued that air power should not act independently but in close coordination with the other military branches „its mission should complement those of other services„ (Murray, 1983:7). Robert Knauss promoted the concept of strategic bombing with the goal of demoralizing the enemy population and causing internal collapse: „a totalitarian society like Nazi Germany would prove more capable of enduring bombing attacks than the fractured societies of Britain and France„ (Murray, 1983:10). This idea played a significant role in the development of Luftwaffe doctrine, as would become evident during the war.

However, the Luftwaffe required a real challenge to demonstrate its capabilities, and the year 1936 provided such an opportunity.

3. AIR WARFARE IN THE SPANISH CIVIL WAR

The Spanish Civil War (1936–1939) provided Nazi Germany with the perfect opportunity to test its newly developed Luftwaffe in combat conditions and refine its doctrine and tactics. Hermann Göring realized that Spain offered a valuable occasion to test his creation. Furthermore, Spain served as a useful distraction from Germany's ongoing rearmament program: „Hitler willingly provided substantial aid to the rebels, especially in the air, but regarded the war mostly as useful in distracting Europe's attention from the growing danger of Nazi Germany„ (Murray, 1983:15).

In this theater of operations, the German forces aimed to implement their emerging maneuver warfare tactics. The Luftwaffe's first task was vital for General Francisco Franco's army, who requested German assistance in transporting troops from Morocco to the Iberian Peninsula. This marked the formation of the Condor Legion, commanded by General Hugo Sperrle and Colonel Wolfram von Richthofen. The mission was carried out using nine Junkers Ju 52 aircraft: „Following the outbreak of the Spanish Civil War in July 1936, the Luftwaffe dispatched nine Ju-52 transport aircraft that played a critical role in bringing Gen Francisco Franco's forces over from Africa to the homeland„ (Van Creveld et al.,1994:28).

The Condor Legion was a unit composed of volunteers from the German Air Force and the German Army. A total of 16,000 German troops served in the Spanish Civil War, including „approximately 5,000 in the air force, along with 150 aircraft of various types: liaison and reconnaissance planes, ground-attack aircraft, fighters, light bombers, and transports„ (Van Creveld et al.,1994:29).The unit operated autonomously and answered solely to Franco. The commander was always a Luftwaffe general. However, Spain's geography limited the use of maneuver warfare. Its predominantly mountainous and varied terrain, coupled with a lack of adequate road infrastructure, made the rapid movement of large forces exceedingly difficult: „If the Germans had hoped to make Spain into a showcase of modern operative warfare, they were disappointed. Spain, by

virtue of its geography, was not a single theater of war but several,, (Van Creveld et al.,1994:29). Despite the suboptimal conditions for ground forces, for the Luftwaffe, Spain served as a valuable testing ground for its aircraft and tactics: ,,For Luftwaffe, Spain was a helpful testing ground for its aircraft and tactics,, (Murray, 1983:15).

For the first time, German fighter planes faced off against Soviet aircraft, only to realize they were technically inferior. The He-51 biplane was no match for the Soviet supplied I-16 Rata : ,,He-51, a biplane with fixed landing gear, was completely outclassed by the Soviet-supplied I-16 Rata,, (Van Creveld et al.,1994:32). As a result, the He-51 was repurposed as a close air support aircraft, where it achieved notable success. Moreover, this campaign saw one of the earliest examples of bombers being used to pave the way for ground troops—a rudimentary form of what would later become known as Blitzkrieg: ,,Bombers, operating with fighter support, blasted a way for the infantry,, (Van Creveld et al.,1994:32). General Walther Wever's doctrine, which emphasized both strategic missions and joint operations, was actively tested and refined. Both strategic and tactical bombings were carried out, including the infamous bombing of Guernica. Although the act was one of terror, it provided practical experience in aerial bombardment and its psychological effects. Nevertheless, the outcome of strategic bombing was considered undesirable, prompting Germany to redirect its military investments elsewhere. This led to the emergence of new concepts, such as the ,,four-finger formation,, (Van Creveld et al.,1994:33), as well as a deeper study of how to coordinate closely with ground forces: ,,The nature of ground organization needed to support air warfare was studied in depth,, (Van Creveld et al.,1994:32). Shuttle and relay attacks were also developed, wherein aircraft repeatedly targeted the same objective in rapid succession, thereby maximizing their impact on enemy morale and forces.Another tactical consideration led to operational innovation. Richthofen adopted the shuttle air tactic. In order to maximise support over the frontline, aircraft operated from bases near the front to keep and gain an advantage. Furthermore, Wolfram von Richthofen, who began his career in Spain as the commander of the Condor Legion, gained substantial experience in close air support operations: ,,It was to turn him into perhaps the world's leading exponent of close air support,, (Van Creveld et al.,1994:32).

In this regard, the Spanish Civil War represented a highly valuable experience not only for the Luftwaffe but also for the development of the Blitzkrieg doctrine that would later devastate Europe. One major issue that emerged during this period, however, was the lack of effective communication between the air force and ground forces, resulting in poor coordination: ,,No progress had been made in the coordination of air power with armored forces,, (Van Creveld et al.,1994:34).

4 AIR OPERATIONS IN THE INVASION OF POLAND

With the return of the Condor Legion in Germany in May 1939, the experience it brought back from Spain proved crucial for the upcoming campaign. However, one of the assesments made by Wolfram von Richthofen was that some army generals were incapable of understanding the capabilities and power of air supremacy ,,was to regard the army as unteachable,, (Van Creveld et al.,1994:34). The experience in Spain had shown that transport planes were invaluable to logistics, and with Richthofen's input, they were accordingly expanded. The most difficult aspect of close air support remained communication. Air-ground liaison officers had been in use since 1935, when the Luftwaffe first established a training program for this purpose (Wikipedia, https://en.wikipedia.org/wiki/Wolfram_von_Richthofen, accessed April 5, 11:51).

A new tactic that would revolutionize modern warfare emerged within Luftwaffe doctrine: the destruction of enemy air forces on the ground through surprise attacks "but the doctrine of the Luftwaffe emphasized surprise attacks to destroy the enemy air forces on the ground, not extended air-to-air combat,, (Addington, 1994:187).

One of the most important strategies adopted after the experience in Spain was the strong cooperation between air and ground forces ,,the development of close air support and cooperation with the army came directly from the Spanish Civil War. In 1939, the Luftwaffe was closer than ever to realizing the full potential of the aircraft, while its doctrine of close air support and cooperation with the army placed the German air force in a position to decisively impact the coming battles, alongside the army's armored units,, (Murray,1983:15-20). The organization of the German air forces was unique, as they were geographically distributed. Thus, the idea was to facilitate operativ warfare by assigning separate air commands to each major force: in this case, the army group coming from East Prussia was supported by Luftflotte 1 (First Air Fleet). Each air fleet contained aircraft of all types, air-ground communication crews, and specialized personnel capable of quick redeployment.

On September 1st, 1939, at dawn, German forces surprised the Polish air force while it was still on the ground with a surprise attack. Unfortunately, unfavorable weather conditions prevented the efficient deployment of German forces; however, ,,within three days some 2,000 German warplanes had destroyed most of the Polish air force of a thousand aircraft,, (Addington,1994:199). It is clear that the Luftwaffe's first mission was to achieve air superiority by destroying the enemy's air force through a surprise attack ,,the first time in which a country had employed this tactic that was later to become a standard in the hands of all attackers,, (Van Creveld, 1994:36).

Additionally, armored forces broke through the poorly defended Polish front, heading directly toward Warsaw. In these circumstances, "the German Wehrmacht was able to practice maneuver warfare for the first time and on a grand scale" (Van Creveld,1994: 36).

Another successful mission fulfilled by the Luftwaffe was that of behind the front interdiction. As armored and mechanized forces advanced, gaps formed on their flanks that could have been exploited by the enemy. However, the Luftwaffe provided close air support, preventing the enemy from advancing and cutting off their route ,,by striking deep into the rear of an enemy counterattack, was able to protect one of those long exposed flanks that were the natural result of German-style operativ warfare,, (Murray, 1983:39). ,,On the ground, for the first time in modern warfare, the combination of mobile armored formations supported by aircraft proved devastatingly effective. Interdiction strikes made it impossible for the Poles to move large troop formations in the open, while attempts by Polish units to break out of encirclements collapsed under Luftwaffe bombing,, (Murray, 1983:31). The Junkers Ju 87 Stuka dive bombers were effectively used as "flying artillery," delivering precise and devastating strikes against Polish forces and directly supporting the German advance.

Radio communications enabled unprecedented coordination between ground and air forces, allowing for rapid and decisive maneuvers. This real-time communication and coordination capability was a key element in the success of Blitzkrieg operations ,,by striking deep into the rear of an enemy counterattack, was able to protect one of those long exposed flanks that were the natural result of German-style operativ warfare,, (Murray, 1983:39). The destruction of Polish communication networks and rail lines by the Luftwaffe severely hindered Polish troop mobility and logistics, accelerating the German advance and creating significant logistical difficulties for the Polish forces.

Soon after, the panzer divisions under General Walther von Reichenau reached Warsaw, and the capital was encircled. Another newly employed tactic was the aerial bombing of a besieged capital. This mission was assigned to Wolfram von Richthofen ,,requested permission to destroy Warsaw completely,, (Murray, 1983:31).

After the Soviet Union invaded Poland from the east, and with the fall of the capital, the country capitulated in just 35 days. Despite some transport aircraft losses during the Polish campaign, they were considered acceptable given their crucial role in supplying advancing troops. The Luftwaffe conducted 3,018 supply missions, significantly contributing to the campaign's success. ,,The final verdict must be that, although material results were often meager, air power caused widespread demoralization and disorganization, including the disruption of Polish telecommunications network,, (Van Creveld, 1994:37).

5. THE UNIQUE AIR MISSIONS IN THE LOW COUNTRIES

After the capitulation of Poland, Germany began preparations to replicate the Schlieffen Plan in order to invade France through the Low Countries. This course of action was prompted by the fact that, during the interwar period, France had constructed along its border with Germany an impenetrable line of fortifications—the Maginot Line. However, this plan was compromised when ,, a German liaison plane force-landed at Machelen, Belgium",, (Van Creveld, 1994:41).

As a result, the Allied forces repositioned themselves in a manner intended to block the maneuvers outlined in the Schlieffen Plan. This maneuver was well suited for dealing with a repetition of the Schlieffen Plan. However, this realignment left the Ardennes forest region unguarded—an area the French regarded as impassable. ,,However, it exposed the Allied rear to a counterstroke delivered by way of the Ardennes,, (Van Creveld, 1994:37).

Through this deceptive maneuver, the German army successfully laid the groundwork for a surprise attack through the Ardennes. Forced to revise their initial operational plan, the Germans adopted a new strategy: ,,the Germans went on to apply another fundamental principle of war when they built a very heavy concentration of forces,, (Van Creveld, 1994:37).

This concentrated force was to serve as the spearhead of the impending invasion. The German army was divided accordingly: ,,From north to south, the army groups consisted of Army Group B,, (Addington, 1994:202) which was supported by "Luftflotte 2 under Gen. Albert Kesselring", tasked with the invasion of Belgium and the Netherlands; and Army Group A, "Luftflotte 3 under General Sperrle was detailed to support the critical Army Group A,, (Van Creveld, 1994:42-43) which was to serve as the scythe that would cut through Sedan and descend toward the mouth of the Somme River. Army Group B played a central role, as it was intended to encircle the entire Allied force—it was the Germans' the hidden trump card. The German military was thoroughly prepared for this invasion, enjoying several significant advantages over the enemy, such as the initiative, superior momentum, and more advanced equipment. "They had a unified command system that enabled them to share information throughout the forces and to shift resources from one point to another as the leadership saw fit,, (Van Creveld, 1994:43).

On the 10th of May, the invasion commenced with a surprise aerial strike on enemy airfields: ,,at dawn… bombers attacked 22 airfields in the Netherlands, Belgium, and northern France,, (Van Creveld, 1994:46). The attack was devastating for the Allies, with the British forces being the only ones to escape largely intact. Within only ten days, the Luftwaffe had destroyed more than 2,000 aircraft.

These figures were almost certainly exaggerated; still, the fact remains that by the end of no more than one week, the Dutch, Belgian, and French air forces had been eliminated as fighting organizations. German losses amounted to approximately 1,130 aircraft.

Following the completion of the first phase of the invasion, the ground offensive began, heavily supported by Luftwaffe. Another first for the German military was the operational deployment of paratroopers: ,,To them, airborne warfare was a question of neither simple descents into the enemy's rear… airborne forces were seen as can openers,, (Van Creveld, 1994:45).

Consequently, the next objective for the Luftwaffe was the capture of key bridges in the Netherlands. Among them were the bridges over the Albert Canal, which constituted a formidable antitank ditch… had to be crossed if Belgium was to be invaded. Shortly after the surprise aerial bombardment, Dutch bridges were seized by three battalions of paratroopers.

Another high-priority objective was the Eben-Emael fortress, which was successfully neutralized by a small elite detachment of German paratroopers. Thus, Army Group B advanced swiftly through Belgium, the Netherlands, and Luxembourg in no more than fifteen days. As Allied attention became increasingly fixated on this advance, Army Group A was neglected, an oversight that would prove to be a critical strategic misjudgment.

6. THE SUCCESS OF THE LUFTWAFFE IN FRANCE

As we know, in just 10 days the French Air Force was eliminated by the surprise air attack. Meanwhile, in the same day, " Rundstedt's powerful Army Group A,, Addington,1994: 206) began its through Ardennes. On the 13th of May , the german panzers passed Sedan and penetrated the defensive line. The French troops were constantly bombarded by the Ju-87 Stukas, therefore becoming unable to stop the german advance. After crossing the Meuse river, Allied planes tried to bomb the bridges and the troops but the Luftwaffe destroyed them ,, the RAF took so many losses that its bomber arm on the continent almost ceased to exist,, (Van Creveld, 1994:51). Shortly after this incident Army Group A was free to advance deeper in the enemy territory. Luftwaffe also carried interdiction missions in order to stop the French army from cutting off their advance .

Due to their fast pace, the Luftwaffe had to make air drops to provide with ammunition and petroleum, oil and lubricants. Once the supply problem was solved , they were able to advance unopposed . On the 20th of May the German army reached the English Channel. The Allied forces were trapped in Dunkirk. " The next stage of the campaign led to one of the more controversial episodes of the war, the famous "stop order" that resulted in the eventual escape,, (Murray, 1983:38) of the Allied forces. On a different note, the british started the famous Operation Dynamo to rescue all the trapped forces.

While the army had stopped , Goering proposed to Hitler to let the Air Force destroy the trapped allies. Unfortunately, when the troops got permission to attack, it was too late because the allied had enough time to get entrenched and had begung a full-scale evacuation. Now it was the time for the Luftwaffe to take over the task, but they were fighting at a disadvantage. ,,Even after three weeks of campaigning , the bulk of its forces still continued to operate from airfields in western Germany,, (Van Creveld, 1994:52). Thus the range of the german fighters was far inferior than the allied planes.

So when the He -117 wanted to bomb the embarking forces the RAF intervened in a significant fashion and humiliated them. The Luftwaffe lost 240 planes while RAF only lost 177.

After the evacuation, France was left alone in the continent and their doom was imminent. „Their hopeless military position made defeat quick and brutal„ (Murray, 1983:39). The efficiency of the campaign was due to the significant attrition caused by the German armored and air forces. To sum things up, the Luftwaffe used never seen before tactics like : first achieving „air superiority through combining air-to-air combat with attacks on the airfields and rear installations, next came the use of airborne forces as can openers at selected points and finally the behind the front interdiction„ (Van Creveld, 1994:53).

7. AIR WARFARE IN OPERATION BARBAROSSA

With Europe conquered and the Battle over Britain lost, Hitler decided that Operation Sea Lion is out of question, thus the only logical next step was to invade the Soviet Union. Soon enough, the ground work for the invasion has begun. The ground forces were divided into three armies: „ From left to right , these were Army Group North … ; Army Group Centre …; and Army Group South„ (Van Creveld, 1994:63). These groups had individual objectives in order to facilitate the operativ warfare. Each one of these groups was assigned Luftflotten in order to assist it in the following invasions.

Two of the greatest difficulties of this campaign was the great distances between the main objectives and the fact the theatre grew laterally as the Germans pressed east, thus expanding the already huge frontline. The Luftwaffe after the battle of Britain was in a bad shape and received the news with mixed feelings . With the experience gained in the previous campaigns, Luftwaffe had clearly defined tasks like using a surprise attack in order to disable to Soviet Air Force, gaining and maintaining air superiority, assist the ground forces and destroy the railway networks. Before the war, Germany flew numerous photoreconnaissance mission inside Soviet territory, thus gaining the necessary intelligence.

After a short preparation, on the 22nd of June 1941, at 0300 the Luftwaffe opened the campaign by the now standard method of surprise strike at the enemy airfield".The attack was flawless, by crossing the frontier at high altitudes, the planes didn't alert the enemy forces, and when the objective was in sight, they dived and destroyed it. By the end of the first week, the Soviet Air forces was in shambles and by 12 July Soviet losses had risen to about 6850. As soon as air superiority was achieved, the Luftwaffe started supporting the ground forces and disrupting the railway network „aided by the Luftwaffe close air support and interdiction missions , German armies surged forward against a collapsing opponent„ (Murray, 1983:82).

The Luftwaffe played a vital role in directly supporting these ground forces, acting as „aerial artillery„ to overcome Soviet resistance and enable deep penetrations into enemy territory. The Junkers Ju 87 Stuka dive bomber was particularly effective in this role, delivering accurate attacks against key Soviet objectives such as artillery positions, command posts, and troop concentrations, often just ahead of the advancing panzers. In addition of providing direct support to the advancing ground forces, the Luftwaffe also engaged in interdiction missions , targeting critical elements of the Soviet logistics behind the lines. This event allowed the german army to encircle the enemy, thus creating some of the biggest pockets of troops in the history of warfare. When there was no other way to reach the army, they flew supplies to them so that the push would not stop.

Within 4 days, the Baltic front was in shreds, while in Belarus, an enormous double envelopment happened around the cities of Byalystok and Minsk. By now, the german panzers have advanced so far, that they left their flanks undefended, so the Luftwaffe had to „ leap into the breach and to identify and prevent counterattacks from developing into dangerous threats,, (Van Creveld, 1994:73). Soon enough, the autonomy of the Luftwaffe decreased, because of those missions, becoming more of a fire brigade, the only thing the leaders had always wanted to avoid. A crucial tactic for the Blitzkrieg to work properly was for the Luftaffe to operate from the recently captured Soviet airfields, in order to be able to reach and assist the quickly advancing panzer corps. Before long, the germans „troops could move forward as fast as their vehicles, supplies and weather conditions would permit,, (Murray, 1983:83) reaching the cities of Leningrad and the capital of Moscow.

In the south, the Wehrmacht reached the banks of the Dnieper. Having Smolensk captured and the supply situation improved, Guderian's panzer corps dug deeper in Ukraine from Gomel in order to link with Ewald von Kleist's forces coming from Kiev. The Luftwaffe was undoubtly vital for the advance of Guderian by doing close air support and interdiction missions therefore having prevented a counterattack by Soviet forces coming from the Lubny-Lokhvitsa-Priluki-Yagotin area and helping to capture the city of Kiev and creating the biggest encirclement in the history. Pretty soon, the Germans commenced operation Typhoon in order to capture Moscow. The Air force started to raid Moscow and the sorroundings of the city in addition to the already ongoing interdiction missions and logistical strikes. Unfortunately the winter came and put a halt to the german war machine. „Seen in retrospect, the German campaign in Russia in 1941 was the greatest display of maneuver warfare in history and it will likely remain so in the future,, (Van Creveld, 1994:93).

8. CONCLUSIONS

Military aviation brought a revolution in the conduct of warfare during the 20th century. The interwar period and the early stages of World War II marked a shift from the static, attritional conflicts of the First World War, ushering in a new era of mobile, integrated warfare in which air power played a decisive role. The Luftwaffe exemplified this paradigm shift, demonstrating how air superiority, close air support, strategic bombing, and interdiction missions could profoundly alter the outcome of military operations.

The impact of aviation extended beyond the tactical and operational levels, generating strategic, doctrinal, and psychological consequences. Through its ability to project force rapidly and deeply into enemy territory, air power required a fundamental rethinking of traditional military doctrines and led to the reorganization of modern armed forces. At the same time, the destructive effects of aerial bombardments on urban centers had significant repercussions on civilian morale, the economic reshaping the concept of the war .

In conclusion, aviation fundamentally revolutionized modern warfare, not only through its technological capabilities but also by reshaping global military thought. The doctrinal legacy of the Luftwaffe and the early air campaigns of the 20th century continue to influence the conception and application of air power in contemporary military operations.

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AERIAL ADVANTAGE: THE TACTICAL IMPACT OF DRONES ON BAKHMUT'S DEFENSIVE OPERATIONS

Mihai-Dorin BEȘTI

Coordinator: Cdor (r.) Lect **Jănel TĂNASE**. PhD

"Henri Coanda" Air Force Academy, Brasov, Romania

Abstract: *This paper aims to highlight the strategic effectiveness of drones used in defensive manners when accounting for the lack of other viable means of protection against imminent threats. By displaying the necessary information highlighting how Bakhmut acted as a key city for the Russian offense plan against Ukraine and how such a city was overtaken, a more thorough painting depicting the strategic and offensive capabilities of the Russian offensive can be drawn. Furthermore, this paper will delve into the fantastic defense of the Ukranians using drones and what measures did the Russians take to try to stop them. Given the tense and dissonant views portrayed in the media, misinformation and contradictory statements grow and flourish at an alarming rate. As, an extensive segment has been dedicated to clarify what fake news I have found about this battle.*

Keywords: *drones; war; Ukraine; fake news; innovations.*

1. INTRODUCTION

It's 2022, the Russians have retreated from northern Ukraine and ceased any further advancements in the south. There is but one imperative goal they have in mind: conquering Donbas, an eastern region formed of Luhansk and Donetsk, more so decimating the Ukrainian army which is concentrated in that region. To do so, the Russians enact a three-pronged offensive: from Izyum in the north, Donetsk City in the south and from Luhansk in the east, all with the same goal - reaching the cities of Sloviansk and Kramatorsk. Unfortunately, the northern and southern offensives stagnate and dissolve swiftly, leaving the Russians with the only option of centralizing all their efforts on the east. Bakhmut proves to be the only road-bump left on the attackers' way to their goal. If they manage to take the city, such a victory could pave the way to increased offensive capabilities within the entire northern Donetsk region, with possible attacks on the cities of: Soledar, Siversk, Konstantinivka, Toretsk and finally Sloviansk and Kramatorsk.

2. WHY BAKHMUT?

The importance of Bakhmut, at face value, poses a question of relevance and importance in this constant ongoing war. However, delving deeper into the geographical and strategic connotations of this city, a better understanding of the Russians' desperate strive to claim it becomes clear. Bakhmut contains the intersection of four major highways, that, if captured by opposing forces, can be used as a logistics hub to furthermore shift the tides in the support of the Russians.

The highways are as follows: T0504 and O0504, which connect the city to Chasiv-Yar and Konstiantynivka, T0513 which passes the city from north to south coming from Sivers'k and going to Andiivka, with the last one being the continuation of the T0504 east part of the city, facing the Russian side which can be used to further supply, the city being situated in the valley of the river Bakhmutoka, surrounded by high-ground, proving advantageous for the Russian offensive given the possibility to indirectly attack the city with artillery barrages. However, the river itself will prove arduous for the Russians offensive to cross and take the city. Furthermore, the north-east of the city contains a forest, providing camouflaging opportunities for the soldiers and equipment. "A Russian reporter who filmed Wagner's front-line positions near Bakhmut late last month reported that Prigozhin's son was fighting there, and interviewed him, without identifying him by name. ""Bakhmut is a road to many directions. It's a very important point strategically for the Ukrainian forces and for us", another fighter said in the video. "Their team is ready to fight until the end, no matter what the losses are.""[1]

3. HOW THE BATTLE WORKED OUT

With the beginning of October 2022, Prigozhin announces the start of what he calls: "Operation Bakhmut meat grinder" and promises to Putin that the city will fall by the end of the year. Defending the city are the following brigades: 93rd mechanized in the northern city of Soledar, which will heavily rely on drones, 58th motorized in the east of Bakhmut, 30th mechanized, 4th rapid reaction and the 112th territorial defense in the south-east of the city in the villages of Zaitseve and Vasela Dolyna. On the offensive, there are two Russian units in the north, 76th air assault division and the Akhmat battalion, backed up by soldiers from the Luhansk People's Republic, 5 Wagner divisions in the east of Bakhmut, and one more in the south with 2 more divisions from the Donetsk People's Republic. There are around 20.000 Ukranians and 30.000 Russians. The first push happens south, where the villages of Zaitseve and Vasela Dolyna are the first to fall, being captured by the Wagner forces. Ukraine responds by rushing reinforcements, 11 divisions to be exact, while the 4th rapid reactions takes heavy losses and resorts to retreat. At this point the Ukranians outnumber the Russians 2 to 1, 60.000 to 30.000, but the Russians have a firepower superiority of 5 to 1, evening the battlefield. Wagner tries a direct attack but the industrial zone present in the eastern outskirts of Bakhmut proves to be very difficult to attack, resulting in a failure. By November, there is another push in the south, where Russian forces push the Ukrainians all the way to the cities of Andiivka and Klishchiikva cutting of the T0513 highway. Through such an advancement, they managed to block one of the four main roads leading into the city, proving crucial for cutting the defenders' supply routes. Ukraine attempts to retaliate with two more divisions, yet the force of the Russian military proves too strong, steadily advancing in this fierce battle for territory. In December, the 93rd mechanized brigade launches a counter attack trying to get back Yakalivka, leading to an unfortunate failure and heavy casualties, resulting in a retreat once more. In the same time, Wagner and his forces advance to the outskirts of Bakhmut. There is another wave of reinforcements, this time for both sides, 10 divisions for the Ukranians including the elite 3rd assault brigade and 5 brigades for the Russians. Unfortunately, exact numbers are scarce and lacking clarity, yet personal calculations have estimated that there are around 80.000 to 100.000 Ukranians and around 80.000 Russians battling for Bakhmut. The new year brings a new breakthrough for the attackers, where they manage to push the defenses past the northern continuation of the T0513 highway, which connected the city to Sivers'k, another important supply road for the defense.

Furthermore, there is another breakthrough this time in the south, where the Russian forces manage to advance to the city of Klischiivka and easily control the T0504 highway, leaving the Ukrainians stranded with just the O0504 for supplies, which will also be known as "the road of life". By February 2023, Wagner has reached the Bakhmutoka river inside the city, pushed all the way to the Siviersk-Donetsk canal in the south and in the north they advanced to the city of Khromove, through which the O0504 passes. But the Ukranians refuse to acknowledge defeat, doubling down and deploying the Kraken special forces to defend the roads. Finally, due to the dangerously close advancements of the Russian opposition, inching ever closer to key road positions, the Ukrainians relinquish their defenses in the city and retreat to its outskirts where they manage to hold an incredible last stand for six weeks. In May 2023 all of the Ukrainians that were fighting in Bakhmut have retreated and the city is captured by Wagner.

4. THE RISE OF THE DRONES

I think, by know, everybody has heard about the use of drones in the Ruso-Ukrainian war, I mean every news about the war has something to say about drones. This has also been noticed by NATO which write the following:" In conclusion, the reports indicate that, almost two years into Russia's war against Ukraine, new realities of war are emerging characterized by, among other factors, extensive use of drones"[2], proving that the face of aerial warfare is rapidly changing, changing in a way that helps the weaker country, Ukraine in this case. But the questions stands: When, how and why did they start using drones? It's pretty clear that Ukraine does not have the industrial capabilities of Rusia so they need to improvise: "The Russians have the soldiers, the guns, everything. We need to be smart"[1], said a Ukrainian solider named Vlad, and smart they were. Since the beginning of the war Rusia has not been able to obtain the key to winning the war: aerial superiority; mostly due to the incredible anti-air capabilities of the defense which significantly weaken the Russian air force by not being able to use the modern fighter jets that they possess: "Both sides increasingly resorted to the extensive use of drones after the Russian air force singularly failed to gain air supremacy in the opening stages of the invasion. This came as a surprise as it was widely anticipated that the Ukrainians would be rapidly overwhelmed both in the air and on the ground. The failure of the Russian air force was partly due to its very limited performance and rapid improvements in Ukrainian air defenses. Many risk-averse Russian pilots resorted to firing their missiles from their own airspace due to the threat posed by man-portable surface-to-air missiles. Despite extravagant claims by either side, there were very few actual dogfights. Ground fire accounted for most of the air losses."[3] Some call it the detechnolization of aerial warfare: "Ironically, aerial warfare having gone hi-tech for so long has increasingly resorted to low-tech solutions."[3]; but this way, they are able to produce much more aerial and close air support fighting capabilities. For example, in the 7 years that WW2 has spanned, The German Reich managed to build around 95.000 airplanes of all types while only in 2023 Ukraine produced 300.000 drones" Mykhailo Fedorov, Ukraine's minister for digital transformation, told Reuters agency in 2024 that Ukrainian production in 2023 was 300.000 drones and one third of those were made available to combat forces. Moreover, an additional large number was delivered to the soldiers from different sources."[4]

This would have not been achievable without a switch in the industry which in its case was massive: "The last 18 months of war have sparked a "major shift" in Ukrainian unmanned vehicle manufacturing, Fedorov said.

"In a year, Ukrainian drone's industry produces different types of drones: FPV [first-person view], strike, bombers, large radius drones," he added. "Prior to the full-scale invasion, Ukraine's industry has been focused mostly on air reconnaissance." [9]

5. THE WAR OF COMERCIAL DRONES

One key tactic display spanning this war proves to be the adaptation of commercial drones for military uses. Such a workaround came as replacement for the expensive military drones that were shut down and were too costly to replace: "Due to the effectiveness of intelligence, surveillance and reconnaissance UAVs, it is no surprise that both sides made a high priority of either jamming UAVs or shooting them down. As the war continued and more and more specifically military drones were lost, both sides and Ukraine in particular started to replace their expensive purpose-built advanced technology military UAVs with adapted commercial models, thus significantly reducing costs." [6]; however, such a tactic had its crippling drawbacks as well because the technical characteristics of these drones were readily available on the internet due to the commercial nature of the drones. It was not until later in the war, when Ukraine brought software advancements and improvements, that they were able to impose drone superiority: "In regards to the future of Ukrainian drones, we will present some lessons identified. It is obvious that Ukrainians did not obtain an operational or strategic advantage due to the drones utilized in the war because the majority of drones were commercial and the technical characteristics were available to anyone, thus any improvements were known also by the enemy. Even the fact that Ukraine used at first the first-person view (FPV) drones in kamikaze attacks creating do-it-yourself (DIY) cheap kamikaze drones allowed the enemy to quickly adapt to the improvement developing their own type of drones. Ukraine was the best at utilizing commercial drones in a wartime setting. The Ukrainians were not able to leverage technologies and software advancement to impose the drone supremacy because, at the beginning of the war, the enemy had a large inventory; and, in 2023, the implementation of war production drones domain creates a larger capability on disposal."[4] But civilian drones had some innovations that proved to be very useful on the battle field. Let's take for example a drone that has been vastly used, the DJI Mavic-3. First of all, the drone is extremely easy to fly and use it to obtain vital information about the battlefield: "the DJI standard flying apps come loaded with camera and recording features. At its simplest the app allows you to adjust the camera and capture photos, or to start a video recording, by clicking on the button in the app."[7]. With just a little bit of training the soldiers are able to fly and capture essential battle field information with the drone: "However, drones have given the average the average professional easy and quick aces to aerial imagery" [7]. A very important feature that I have found about this drone is the ability to follow a person "The apps provide the ability for more advanced uses, including the ability to follow a tagged object (like a person walking, car or biker)" [7]. Furthermore the drone is able to geotag, meaning it is able to put on a map where the picture was taken: "Photos and video captured with a drone can be geotagged (it requires a drone connected to GPS), meaning they have metadata attached to the image that include the location, height, camera information, and much more .This is important information for the drone to capture as it is required for photogrammetry software to create overlaps and process the data. It also provides the ability to create geotag tours in Instagram and other apps." [7]

6. DRONES IN BAKHMUT

So probably by now you may be asking yourself: where did the drones come in play in the battle for Bakhmut? For most of the war, they have been used for precise bombing either with FPV drones or aiding the mortar firing crews; and surveillance of the battle field. As we know, the Russians only had a single road going into the city, a road they will try to defend from drone attacks with ingenious measures that will ultimately fail. The road I am talking about is the T0504 highway coming from Luhansk, the only supply route for the offensive and Ukraine knows that. They will heavily bomb the road with everything they had including: FPV drones, artillery, mortars. This way, they slowed down the offensive, massively impacting the rate at which reinforcement and supplies will arrive, destroying armored vehicles, trucks, armored personnel carriers, narrowing all offensive capabilities solely to coming down the single road. The Russians offence was laden with frustration, seeing as an offensive which was supposed to last around 3 months has been going on for a year and still had a long way to go. So they came up with a solution that they hoped would stop the Ukrainian drone attack: they created a mesh tunnel covering the road; "FPV drone attacks on Russian logistics are a key aspect of the war. Bypassing defenses, the tiny drones go behind enemy lines to chase down trucks and vans bringing supplies to the front line. Trucks already have various defenses, but in one sector in Bakhmut the Russians are going to another level: covering entire road with an anti-drone netting tunnel more than a mile long."[8]. This proved to be very inefficient because the drones can drop bombs or manually explode, which for armored personnel carriers did its job very good: ""For unarmored vehicles or troops, FPV drones can still be highly effective, especially when using manual detonation of fragmentation munitions," says Michael."[8]. Another important use of drones is getting precise information for enemy positions and then being able to have a very precise indirect fire instead of sending a barrage of fire and wasting ammunition: "By 2023 combat trends in Ukraine indicated that cheap, small commercially, off-the-shelf drones can be just as effective and their low cost makes them much more expendable. Their size enables them to carry out intelligence-gathering and even ordnance delivery missions at very low altitude well below radar cover. Although vulnerable to jamming and small-arms fire, they can be easily and swiftly replaced. Furthermore, there is no need for their operators to try to retrieve them when lost."[3]

7. FAKE NEWS

Fake news has an imperative role in the process of misleading the masses, a process started and controlled by political parties from west to east and north to south, each adhering to their own ideas. This constant flow of contrasting views and inaccurate information has spurred me to dedicate a chapter detailing fake news from the battle of Bakhmut, aiming to debunk such claims. A major misinformation was the fact that Bakhmut was only a symbolic prize for the Russians, news agencies filling the internet with titles like: "Wagner chief's Bakhmut win only symbolic, controlled withdrawal unlikely: Think tank"[9], "Bakhmut is more of a symbolic value than operational – Austin"[10] and "In bloody battle for Bakhmut, Russian mercenaries eye a symbolic prize"[10]; However, in reality, as previously described upon in the first and second chapters, Bakhmut proved extremely important for the Russians. Another misinformative piece of information what was spread around news channels is that the armies of the Luhansk and Donetsk People's Republic are made up for forced conscripted Ukrainian residents with articles like:

"Ukraine Symposium – Forced Conscription in the Self-Declared Republics"[11] and "Russia Forces Ukrainians in Occupied Areas into Military"[12] when, in fact, the civilians that wanted to get away from the invasion would have already left, leaving only the Russian sympathizers remaining to voluntarily conscript in the army of LPR(Luhansk People Republic) and DPR(Donetsk People Republic). The next two pieces of western media propaganda I will extract from a YouTube video published by Daily Mail World on the 25thvai g of February 2025 entitled: "30k Ukrainians vs 80k Russian Troops: The Battle for Bakhmut | Battle Board | Daily Mail" where from the title you can already guess the first one: "30k Ukrainians vs 80k Russian Troops". Here they are double crossing themselves because in the video the mention a total of 25 Ukrainian divisions fighting to around 23 Russian ones, and this was happening way before the manpower shortages of Ukraine so the divisions are full and the numbers are even between the both sides, if not better for Ukraine, like I mentioned in the third chapter. The second fake news I found in this video is the tactic of "human wave assaults" that the Wagner were supposedly using: "Human wave tactics are demoralizing the Russian army in Ukraine"[13]. A tactic that was supposed to decimate the attacking side when in fact the Ukrainians were the ones with more casualties in those days.

8. CONCLUSIONS

After reading this article I hope you came to the same conclusions as I did while writing this paper, and realized that drones are not toys to be messed around with and will soon become an essential in every army around the world. I hope I opened your eyes and made you curious about the war next-door and its innovations and lastly please remember to not believe everything you see on the media.

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ONE MAN JUDGED, A SYSTEM EXPOSED: THE TRIAL OF LIEUTENANT CALLEY

Maria-Antonia TESLIUC

Coordinator: Assoc. Prof. **David UNGUREANU,** PhD

"Alexandru Ioan Cuza" Police Academy, Bucharest, Romania

Abstract*: The trial of Lieutenant William Calley for his role in the My Lai massacre remains one of the most pivotal and contentious episodes in the history of American military justice. This study examines the context, legal proceedings and ramifications of the trial, analyzing primary sources and scholarly work to explore themes of responsibility, command authority, legality and memory. The article argues that while Calley was the sole individual convicted, the massacre reflected systemic failures at all levels of the U.S. military establishment. Drawing from the investigative journalism of Seymour Hersh, the scholarly analysis of Howard Jones, and the legal retrospection by Joseph Berger, this article reconsiders the Calley trial as a lens into the challenges of accountability in wartime, the evolution of military law and the shifting moral consciousness of the U. S. Army.*

Keywords**:** *Lt. William Calley; investigative journalism; Seymour Hersh; Charlie Company; My Lai.*

1. INTRODUCTION

On March 16, 1968, soldiers of Charlie Company, 1st Battalion, 20th Infantry Regiment, 11th Brigade of the Americal Division, entered the small Vietnamese hamlet of My Lai. In just a few hours, hundreds of unarmed civilians-old men, women and children- were killed. The U.S. Army initially reported the incident as a victory: 128 Viet Cong combatants eliminated. But the truth, buried beneath layers of military bureaucracy, would not stay hidden forever.

The revelation came not from within the institution, but from a young veteran named Ronald Ridenhour who, disturbed by stories he heard from fellow soldiers, wrote letters to the Congress, the Pentagon and others in power. It was only then that the Army launched a real investigation. When journalist Seymour Hersh broke the story in late 1969, the entire world reacted.

At the heart of the massacre was Lieutenant William Laws Calley Jr., the officer in charge of one of three platoons involved. His name would become famous -reviled by some, pitied by others. His trial in 1971 raised enduring questions: Was Calley a rogue officer or a scapegoat? Can justice truly be served for mass atrocity? And how did this moment shift public perception of the Vietnam War and the moral compass of the U.S. military?

2. THE ATROCITY AND ITS CONTEXT

To understand My Lai is to understand a war that had already torn at the seams of truth and morality. After the Tet Offensive, U.S. commanders turned increasingly to "search and destroy" tactics, seeking to root out Viet Cong forces by scouring villages and increasing body counts as a measure of success. Charlie Company was exhausted and frayed. In the weeks leading up to the massacre, they had lost comrades to landmines and ambushes. Every step in the jungle carried the weight of potential death.

But on March 16, no Viet Cong was found in My Lai. Instead, American troops encountered families making breakfast, children playing, elders squatting in doorways. Confusion quickly turned to catastrophe. Soldiers, already tense and battle-hardened, were swept into a tide of destruction.

What followed was not a firefight but a massacre. Eyewitnesses recall Lt. Calley herding villagers into ditches, giving orders to fire. Soldiers raped women and young girls, executed elders, and gunned down children. Calley, according to multiple testimonies, personally shot civilians and demanded others do the same. The killing was intimate, sustained, and chilling in its organization.

Yet this was not merely the doing of one man. Sergeants like Charles Hutto and David Mitchell were also implicated. And beyond My Lai 4, other hamlets like My Khe saw similar atrocities. The rape and sexual violence that occurred during the massacre is less often recounted, but it happened—ugly, brutal, and unprosecuted. The silences speak volumes.

Warrant Officer Hugh Thompson, flying overhead in a reconnaissance helicopter, saw bodies piling in ditches. Stunned, he landed his aircraft between U.S. soldiers and fleeing civilians. He threatened to open fire on Americans if they continued the killing. His act of defiance—saving lives in the midst of hell—is one of the few glimmers of human dignity that day.

3. LEGAL PROCEEDINGS AND THE TRIAL OF CALLEY

In September 1969, Lt. Calley was charged with the murder of 109 civilians. The trial, which began in late 1970, became the longest court-martial in Army history. But this was no ordinary prosecution. Captain Aubrey Daniel, the young JAG officer assigned to try the case, later admitted he had no precedent to rely on—no prior trials for unnamed victims murdered by a U.S. soldier in combat.

Despite enormous pressure, Daniel and his team chose principle. They built the case carefully, conservatively, unwilling to overreach. The goal was not vengeance but justice. They insisted that even Calley deserved a fair trial. "He looked like a kid," Daniel later wrote. "It was hard to believe this boyish young man had done what the evidence showed" (Daniel, 2018: 6-19).

Calley's defense leaned on a painful refrain: "I was following orders." His lawyer, George Latimer, a former Supreme Court justice of Utah and judge on the U.S. Court of Military Appeals, gave the case a legal gravitas. Calley said he was simply doing what his superior, Captain Ernest Medina, demanded—"Get rid of them"(Borch, 2018:1-5).

But the prosecution argued—and the jury believed—that orders to commit atrocity are never lawful. The Nuremberg principles applied, even in the jungles of Vietnam.

Calley was convicted of the premeditated murder of 22 civilians and sentenced to life in prison. Yet within days, political pressure mounted. President Nixon intervened, ordering Calley placed under house arrest. What began as a rare act of military accountability quickly became a cultural flashpoint, dividing the nation.

4. PUBLIC REACTION AND CULTURAL DIVIDE

The Calley verdict did not bring closure—it opened a wound. For many Americans, Lt. Calley became a symbol, though not all agreed on what he symbolized. Some saw him as a villain who had violated every moral code of warfare while others viewed him as a scapegoat, a foot soldier punished while higher-ranking officers walked free.

Supporters flooded Calley with letters, donations, and prayers. Country music stations played "The Battle Hymn of Lt. Calley" (song by C-Company, 1998) which soared in popularity. For these supporters, Calley was a tragic figure, a young man forced into an unwinnable war by bureaucrats and politicians, only to be sacrificed for their failures. Protesters carried signs reading "Free Calley" and "Our Soldiers, Right or Wrong."

But others could not accept that narrative. To the anti-war movement, Calley's conviction affirmed what they had long suspected—that Vietnam was not only a political mistake but a moral catastrophe. Folk singer Pete Seeger, in "Last Train to Nuremberg," asked pointedly: "Who gave the orders? Who paid the taxes? Tell me, is this blood upon my hands?".

For many veterans who had served honorably, the trial was also painful. It cast a long shadow over their service and raised haunting questions: Could it have been them? Could fear, pressure, or orders have turned them into perpetrators? The trial forced Americans—soldiers and civilians alike—to confront not just the facts of My Lai, but their own complicity in the war.

Calley himself remained a conflicted figure. During the trial and in later interviews, he expressed regret—but his declarations lacked accountability. "I was ordered to go in there and destroy the enemy" (Hersh, 1972: 89-91), he said. "And that was what I did." His words, defensive and tragic, captured a soldier still trying to reconcile duty with destruction.

5. INSTITUTIONAL REPERCUSSIONS AND LEGAL REFORMS

If My Lai was a rupture in the fabric of American military conduct, the response revealed how institutions handle their own failure. The Army's internal investigations—most notably the Peers Commission—documented a chilling list of failures not just by Calley, but across the chain of command.

Major General Samuel Koster, commander of the Americal Division, found out in the early hours that something had gone terribly wrong. Body counts didn't make sense. A helicopter pilot had reported a massacre. Intelligence even intercepted Viet Cong propaganda describing a mass killing. Yet Koster failed to investigate. He failed to report. And ultimately, he failed to protect the integrity of his command.

Though Koster avoided court-martial, he was administratively punished—demoted and stripped of honors. His story, largely forgotten today, is a reminder that accountability often stops short of full justice. Others, like Colonel Oran Henderson and Captain Ernest Medina, were tried and acquitted. The burden of guilt, it seemed, fell squarely on Calley's shoulders.

But there was change. Real change. The Department of Defense, shaken by My Lai's revelations, restructured how it trained soldiers on the laws of war. Judge Advocate General (JAG) officers became integral to operational planning. Legal education was no longer reserved for the courtroom—it was brought to the battlefield. Soldiers were taught not just how to fight, but how to integrate ethics so that the International Humanitarian Law is respected.

My Lai also led to a shift in how whistleblowers were perceived. Ridenhour's letters were once an act of risk; now they are remembered as a move of morality. And men like Hugh Thompson, once treated as traitors, were later honored as heroes. The Army learned—belatedly, painfully—that silence in the face of atrocity is a form of complicity.

6. CONCLUSION

The story of My Lai is not a story of a single evil man. It is the story of how fear, obedience, institutional failure, and moral blindness can converge to unleash unimaginable harm. Lt. Calley pulled the trigger, yes—but behind him stood a system that taught him to see Vietnamese villagers as the enemy, that rewarded body counts, and that failed to intervene when warning signs appeared.

Calley bore the legal burden. But the ethical burden was national. It was military. It was collective.

And yet, from this darkness emerged light—dim, flickering, but real. Soldiers like Hugh Thompson reminded the world that humanity can and it is vital for it to survive even in war. Prosecutors like Aubrey Daniel upheld justice not out of vengeance, but duty. Whistleblowers, historians, artists, and everyday citizens turned My Lai from a buried secret into a cautionary legacy.

Today, as wars continue across the globe, the questions My Lai raised remain. What is the price of silence? Where does duty end and morality begin? Can a soldier refuse an unlawful order—and should they be expected to?

The My Lai Massacre is no longer just a chapter in history. It is a warning etched in blood. A reminder that the rules of war are not mere legalities. They are the last guardrails of our shared humanity.

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PSYCHOLOGICAL WARFARE AND USE OF FORCE FOR MAINTAINING CONTROL IN THE COMMUNIST ERA THE PITEȘTI EXPERIMENT

Matei-Costin LEMNARU, Alexandru-Ionuț CLOCOȚAN, Andrei BÎRDEA

Coordinator: **Mimi-Carmina COJOCARU**, PhD

"Alexandru Ioan Cuza" Police Academy, Bucharest, Romania

Abstract: *The Pitești Experiment, which happened in Romania between 1949 and 1952 remains the most brutal torture programe in the history of the whole Soviet bloc.*

It was initiated under the leadership of Partidul Muncitoresc Roman and sanctioned unofficially by institutions such as the political police(Securitatea), it aimed to reeducate political prisoners, which were mainly elites, such as students and intellectuals, through systematic dehumanization.

One of the most effective techniques for breaking the spirit was that the victims were not only forced to endure torture, but to also torture their peers, thus erasing the line between victim and torturer, instilling paranoia and the constant feeling that they were alone in their suffering. Directed by Alexandru Nicolschi, and under the supervision of Eugen Țurcanu, prisoners were subjected to immense psychological and physical torture, including isolation, brutal beatings and self-hummiliation.

Through these methods, they were aiming to break the human spirit, forcing the victims to admit to fake crimes, not only admitting to said crimes, but also blaming their own family for crimes they didn't commit and promote the ideology imposed on them by the perpetrators.

The experiment was finally exposed after the regime's fall in 1989, despite it's efforts to hide the truth. This event stands as a reminder of the dangers of totalitarianism, regimes which prioritise control over humanity.

The Pitesti experiment is a lesson, teaching us how weaponised ideology can convert simple humans to instruments of repression.

Keywords: *Reeducation; paranoia; psychological torture; human spirit; totalitarianism; dehumanization;*

1. INTRODUCTION
ONCE UPON A TIME THERE WAS *PITEȘTI*…

If you were unlucky enough during communism to be labeled a dissident, a student, or simply someone seen as an admirer of any political ideology other than communism, you would end up in Pitesti Penitentiary. During the 20th century, between 1949 and 1952, in Romania happened the most complex and brutal experiment in torture across time in the Soviet bloc, The Pitesti Experiment. This went on until the ultra-hardline communists in Moscow were replaced by those less extreme, led by Gheorghe Gheorghiu-Dej. It involved torturing people for the sake of torture. Victims were transformed from students,

teachers, doctors, and priests into torturers themselves, forced to inflict on others the same horrors they had endured.

Thousands of prisoners were tortured here being awakened in the middle of the night with blows to the head, coerced into denouncing friends and family for things that never happened.

2. HISTORICAL BACKGROUND
A TIME THAT SHOULD NEVER BE FORGOTTEN

Before diving deeper into the subject, we should offer some context. At the end of World War II, Romania fell under the control of the Soviet Union and their model of governance, the Stalinist model. The communist regime led by Partidul Muncitoresc Roman (PMR) swiftly eliminated what they thought to be enemies of the state, targeting intellectuals, democrats, teachers, students, priests and many more.The top charge was "collaboration with Germany against Russia," which was the communist militia's favorite accusation. They were also forced to reveal the locations of others in hiding.

The Pitesti Penitentiary turned into the central reeducation site, a place used for transforming political prisoners into communist supporters. The whole operation, unofficially sanctioned by the regime, was supervised by the political police (Securitatea) and placed under the direction of Eugen Țurcanu, former student turned into communist supporter.

Thus, on December 6, 1949, the hell of Pitești was unleashed. "You will die by our hands, now or later," was what prisoners heard between the blows as they struggled to understand how their former comrades had suddenly turned into monsters overnight.

That was the key to the Pitești experiment: dehumanization, constant fear, the reduction of prisoners by other prisoners, fear of speaking to anyone, and total isolation within a human cage.

From that day until early 1952, Pitești hosted the most extensive reeducation process in history, one from which very few survived — and for which no one was held accountable.

3. PSYCHOLOGICAL WARFARE TECHNIQUES
THE REINVENTION OF HELL BY MEN

The Pitesti Experiment used a wide range of psychological tactics meant to destroy inmates' sense of self. A torture method used in all communist prisons, not just Pitești, was forcing inmates to curse their families, their dead, cellmates, themselves, and even God. Despite all this torture, no screams were heard from the cells in Pitești. Besides the fact that the main torture rooms were 3–4 meters underground, no one dared scream. Only two people took their own lives. Among the torturers brought from Suceava, one — Constantin Costea — tried to take his own life. When he realized no one left Pitești alive, he attempted suicide. Though he didn't succeed, he was expelled and thus escaped the moral burden. He was the only torturer to withdraw, the only one to show even a trace of conscience. The rest, even in interviews long after the events, spoke calmly about the horrors they committed. Some felt no remorse; others lied.

The goal of the torture was complete dehumanization — to bring the detainee to a state of despair so deep that they became easy to manipulate. Until 1952, people left Pitești only through death. Those who survived lived with broken minds or became torturers themselves. Some, however, resisted the unimaginable suffering and ended up

confessing the most horrific things about their families, about themselves — crimes, incest, prostitution, robbery, and especially conspiring against the state.

4. USE OF FORCE AND PHYSICAL TORTURE THE WILDEST OF ANIMALS IS *MAN*

In addition to psychological torture there was a brutal regime of physical torture. The torturers, which often were other prisoners, were led to think that they were serving a higher purpose. This was used to blur the lines between prisoner and perpetrator, deepening the psychological trauma. The feeling of betrayal fueled by the prisoners torturing each other only deepened the emotional trauma.

For six months, the detainees at Pitești were beaten daily and subjected to unimaginable torture methods such as being fed feces, having their limbs broken — all to make them confess to imaginary crimes or to speak falsehoods about their close ones, thereby condemning them to the same fate.

The main torture methods used at Pitești included: individual or collective beatings, beatings with belts, circular beatings, broom handles, ox sinews, and shaving brush handles; hanging weights on the back of the re-educated, forcing inmates to stare at a lit bulb, finger crushing, forced consumption of salt followed by denial of water, forcing inmates to bang heads together, making them relieve themselves in their food bowls and eating on all fours from said bowls, hanging with their head in the toilet, burning soles, forced sleeping in fixed positions and many more.

5. THE INSTITUTIONAL FRAMEWORK AND COMPLICITY AND ONE OF HIS NAMES IS NICOLSCHI

The Pitesti Experiment could not have occurred without the deliberate complicity and direction of state institutions. Word of the Pitești Experiment spread beyond the Iron Curtain. Yet the Romanian government in Bucharest continued to deny any involvement or the existence of a similar program.

Alexandru Nicolschi was the director of the Pitești prison and oversaw the entire operation, nothing happened without his approval. During the experiment, everyone involved had code names, and the detainees never knew who Nicolschi was. After the revolution, Romanian Television conducted a series of interviews with some of the torturers. Nicolschi not only denied any connection to the reeducation program, but also blamed the other detainees, claiming the hundreds of reported deaths were just a few natural deaths — and the rest, rumors.

On April 15, 1992, a summons was issued to bring Nicolschi in for questioning in the case brought forward by Romanian Television. On April 16, just one day later, Nicolschi was declared dead, supposedly dying in his sleep of a heart attack, according to the medical examiners.

Furthermore, the academic and ideological apparatus of the regime - universities, propaganda outlets and political commissars - played a part in justifying the need for purification of ideological enemies.

6. AFTERMATH AND ACCOUNTABILITY

The Pitești Experiment ended in 1952, when Ana Pauker and her comrades were expelled from the party

To this day, people like Țurcanu, Nicolschi, Vișinescu, or Gheorghe Crăciun have faced little to no justice for their actions.

The truth about the Pitesti Experiment remained hidden until the fall of the regime in 1989 when the reality of the "experiment" surfaced through testimonies, institutional investigations and memoirs. Until then the survivors were silenced through surveillance, threats and continued repression.

7. COMPARATIVE PERSPECTIVES AND LEGACY SO THAT IT NEVER HAPPENS AGAIN

Even within the wider landscape of the 20th century totalitarian regimes the Pitesti Experiment remains a uniquely horrific episode. While psychological manipulation and torture were common in Stalinist Russia, North Korea and Maoist China, Pitesti's brutal reliance on prisoner-perpetrated violence and the systematic erasure of identity set it apart.

This method of psychological and physical domination inflicted deep, not only on its direct victims but across the entire Romanian society. Many of those that were subject to the experiment were left with permanent psychological damage and irreversible physical damage, and the event remained unspoken even decades after it happened. It was only after the communist regime fell in 1989 that the reality of the atrocities and terrors of the experiment finally surfaced through the voices of the survivors and investigations conducted by institutions like IICCMER (Institutul de Investigare a Crimelor Comunismului și Memoria Exilului Românesc).

The impact of the Pitesti Experiment serves as a reminder of the importance of safeguarding human rights and the dangers inherent in unchecked state power. This "Experiment" shows that even innocent and uncorrupted civilians, under coerced and corrupted systems, can be turned into enforcers of political oppression. Furthermore it's a testament to the endurance of human grit and spirit, as those who survived it went on to speak about the horrors and tortures they suffered and demanded justice to those who inflicted it.

8. CONCLUSIONS & ACKNOWLEDGMENT OUR GENERATION MUST KNOW AND KEEP IN MIND THAT ONCE EXISTED PITEȘTI

The Pitesti Experiment reveals just how far a regime can go when power becomes more important than humanity. Combining psychological torment with brutal violence, the communist authorities in Romania built a system meant to crush personal identity and force blind obedience. This dark chapter in history is not only about cruelty- it's about how easily fear can be turned into a weapon. Understanding this horrific event serves as a crucial tool in comprehending the mechanism of oppression and the resilience needed in order to resist it.

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