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RESEARCH ARTICLE

Artificial Intelligence's Martial Turn: Mapping the Implications for War and International Order – A Study from Historical Perspective

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Abstract

This article develops an original analytical framework explaining how civil-military dual-use potential dictates military adaptation pathways for advanced technologies, validated through comparative analysis of railways (high dual-use to Militarization) and nuclear technology (low dual-use to Weaponization), establishing that Militarization drives Systemic Enablement Effects in warfare and Structural Dynamics Modulation in international relations, while Weaponization yields Existential Determinacy Impacts and Foundational Paradigm Shifts; applied to AI, a paradigm-aligned high dual-use case, the framework predicts its Militarization trajectory while revealing critical findings: cognitive emulation bridges technology-warfare epistemological divides, virtual embeddedness enables controlled escalation fantasies corroding nuclear deterrence stability, and decision-system integration creates uncontrolled escalation pathways, with the study's primary contribution lying in generalizable theory-building for technology-security scholarship where AI serves as both validation vector and boundary-testing case.

Keywords: International relations; Artificial intelligence; International security; Military theory; Technology and war

Introduction

The rapid advancement of Artificial Intelligence (AI) has transitioned from theoretical and speculative domains to exert profound societal impacts. This development presents significant challenges and demands responses across disciplines, including International Relations (IR). While seemingly less immediately affected than others, IR scholars must confront the multifaceted implications of AI, ranging from ethical dilemmas to tangible strategic consequences. Historically, technological innovation and warfare are inextricably linked. Military imperatives drive technological development, while new technologies fundamentally reshape the conduct and outcomes of war (Van Creveld, 2010). Consequently, wars, regardless of scale, exert decisive influence on international relations—immediately altering power balances and, as long-cycle theory suggests, potentially restructuring the international system itself over the long term (Modelski & Morgan, 1985). State survival imperatives ensure that transformative technologies inevitably undergo military application.

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AI, as a pivotal emerging technology, follows this trajectory. Major powers like the United States, China, Russia, and the EU are actively pursuing its military applications. However, systematic IR scholarship analyzing this phenomenon and its potential consequences remains underdeveloped. Existing ethical frameworks and theoretical models appear insufficient to constrain the rapid pace of AI militarization, a gap widening with increased state and private investment (Kissinger et al., 2021).

Addressing this gap, this paper analyzes the impact of AI militarization on warfare and international relations. It employs a comparative historical method, examining the military application of railway and nuclear technologies. From this analysis, it derives an analytical framework distinguishing between Militarization and Weaponization based on dual-use potential. The framework further posits that these modes differentially impact warfare through Systemic Enablement Effects or Existential Determinacy Impacts, subsequently influencing international relations via Structural Dynamics Modulation or Foundational Paradigm Shifts. Applying this framework, the paper then examines the characteristics of AI military application and its potential consequences for future conflict and the international system. The article proceeds as follows: after this introduction, it analyzes the historical cases, develops the framework, and finally applies it to AI.

The History of the Military Application of Railway and Nuclear Technology

Railway

The military application of railway technology followed a trajectory of increasing strategic significance, evolving from logistical support to a core component of national mobilization and war planning. Originating in 16th-century mining ("hund" carts), railways matured with Richard Trevithick's steam locomotive in 1804, primarily serving civilian industry and transport. Friedrich List's proposals in the 1830s marked the first theoretical linkage of railways to military potential, specifically for large-scale troop mobilization (Showalter, 1972). Prussia pioneered practical application after those far-sighted researchers and military officials realized the incredible potential of railway's possible military application. In 1846, it transported 14,500 soldiers, horses, and equipment from Hradish to Kraków in two days to suppress an uprising, demonstrating railways' mobilization capacity (Wolmar, 2010a). During the Crimean War, Britain constructed a limited railway near Sevastopol primarily to address severe logistical constraints, representing the technology's first wartime use, albeit functionally similar to civilian cargo transport under duress (Wolmar, 2010a).

Prussia solidified its leadership in subsequent conflicts. In the Austro-Prussian War (1866), Prussia leveraged its superior rail network (rail density ratio 5:1 vs. Austria) to mobilize 197,000 men and

55,000 horses to Königgrätz within two days, securing an early decisive advantage (Boot, 2006). The Franco-Prussian War (1870) exemplified large-scale “railway war.” Prussia’s nine strategic lines to the front versus France’s four enabled faster mobilization: deploying forces to the border in 20 days versus an expected 24, allowing the movement of 40,000 troops by July 14th, well before the official declaration of war (Stevenson, 1999; Wolmar, 2010a, p.80).

Prussia’s victories catalyzed a European railway arms race. From 1870 to 1914, European rail mileage tripled to 180,000 miles (Wolmar, 2010a, p.126). Pre-WWI investments surged, with France reaching record levels between 1910-1913 (O’Brien, 1983). Strategic rail capacity became paramount: France expanded its front-line lines from 4 (1870) to 16 by 1913, while Germany increased from 9 to 13 (Stevenson, 1999). Rail construction also fueled geopolitical rivalry, notably Germany’s Berlin-to-Middle East “Eastern Plan,” which heightened Anglo-French-Russian fears and contributed to pre-war tensions (Wolmar, 2010b).

World War I revealed both the enabling power and limitations of railway militarization. Initially, German mobilization plans functioned effectively, facilitating the rapid invasion of Belgium. However, as belligerents achieved comparable mobilization capabilities, railways, combined with defensive technologies like machine guns and barbed wire, entrenched the Western Front. Railways sustained massive armies in static positions, favoring defenders and prolonging the conflict into devastating trench warfare, as seen at Verdun and the Somme (Wolmar, 2010a). Conversely, the lower rail density on the Eastern Front allowed for greater operational mobility. Thus, railways fundamentally transformed warfare’s scale, duration, and character, becoming indispensable to the modern state’s war machine.

Nuclear

Unlike railways, nuclear technology underwent a distinct path of weaponization, characterized by its development primarily for military ends and culminating in weapons of unprecedented destructive power with profound existential implications. Driven by fears of Nazi Germany acquiring atomic weapons, the U.S. initiated the Manhattan Project in June 1942 following Einstein’s 1939 letter to Roosevelt. This massive, secretive effort, led by Groves and Oppenheimer, achieved its goal with the Trinity test on July 16, 1945. The subsequent bombings of Hiroshima and Nagasaki in August 1945 demonstrated nuclear weapons’ existential determinacy impact: they decisively ended World War II, obviating the need for a costly invasion of Japan and fundamentally altering the calculus of victory and defeat.

Nuclear weaponization was intrinsically geopolitical from its inception. The U.S. tightly controlled knowledge, initially excluding even its British ally, aiming to secure post-war dominance and shape the emerging international order (Craig & Radchenko, 2008). This monopoly was also leveraged against the Soviet Union. While the Hiroshima bombing primarily sought Japan's surrender, the Nagasaki attack three days later is argued by some scholars (e.g., Craig & Radchenko, 2008) to have been partly motivated by a desire to end the war before significant Soviet gains in Manchuria, thereby limiting Soviet post-war influence in Asia – a view acknowledging the profound geopolitical consequences of nuclear use (Bernstein, 1995).

The Cold War cemented nuclear weapons' role in driving a foundational paradigm shift in international relations. Mutual Assured Destruction (MAD) became the central strategic doctrine. While direct conflict between superpowers was largely avoided ("Long Peace"), intense rivalry manifested politically, economically, ideologically, and through proxy wars. Arms control negotiations (e.g., SALT, START) became a critical, enduring feature of the bilateral relationship. Regardless of perspective (viewing nuclear weapons as stabilizers preventing great-power war or as catastrophic threats eroding civilization), their existence fundamentally redefined state security imperatives, the nature of deterrence, and the very structure of international politics, establishing a global security paradigm predicated on the avoidance of nuclear conflict.

The Analytical Paradigm

The Degree of Civil-Military Dual-Use Potential: Defining the Mode of Military Application

The degree of civil-military dual-use potential constitutes the foundational criterion for classifying the process of advanced technology military application. This parameter not only reflects the intrinsic technical characteristics and original developmental purpose of a technology but also illuminates the primary actors driving its militarization and, crucially, predetermines the mode and magnitude of its subsequent impact on warfare. Technologies exhibiting a high degree of dual-use potential, exemplified by railways, are characterized by:

Developmental Drivers: Innovation is propelled by both military imperatives and compelling socio-economic needs. The technology serves distinct, often parallel, functions in civilian and military domains.

Actors: Military application is pursued by a diverse set of actors, including state entities (governments, militaries) and non-state actors (private firms, commercial enterprises). Diffusion occurs across civilian and military spheres.

Mechanism: Due to its inherent civilian utility and non-weaponized nature, the technology's influence on warfare is primarily indirect and systemic. Its impact stems from its practical application value in enhancing military capabilities (e.g., logistics, mobility, communication) rather than from being a weapon per se. It functions as a force multiplier and enabler.

Conversely, technologies possessing a low degree of dual-use potential, typified by nuclear technology, demonstrate contrasting features:

Developmental Drivers: Innovation is overwhelmingly driven by singular military objectives – the creation of unprecedented destructive power or strategic advantage. Civilian applications are either negligible, derivative, or emerge significantly later.

Actors: The military application process is exclusively monopolized by the state (specifically, government agencies and national security apparatus). Development is highly secretive and state-controlled, with minimal non-state involvement.

Impact Mechanism: Given its genesis and purpose, the technology's impact on warfare is inherently direct and existential. Its logic is one of weaponization – converting core technical principles (e.g., nuclear fission/fusion) directly into weapon systems. Its effect is decisive, capable of terminating conflicts or deterring aggression through the threat of catastrophic consequences, fundamentally altering the strategic calculus of victory and survival.

Modes of Military Application: Militarization vs. Weaponization

The degree of civil-military dual-use potential fundamentally shapes the mode of military application for advanced technologies, leading to distinct pathways characterized as Militarization or Weaponization. Militarization refers to the process wherein technologies with high dual-use potential are integrated into military systems to enhance operational efficiency and systemic capabilities, such as logistics, mobilization capacity, or command-and-control speed, without generating fundamentally novel destructive power. This mode leverages a technology’s inherent practical application value (e.g., the long-distance transport capacity of railways) to optimize existing military functions, resulting in what can be termed systemic "soft power" enhancement. Technologies undergoing Militarization typically function as General-Purpose Technologies (Bresnahan & Trajtenberg, 1995), exhibiting broad applicability across civilian and military domains. Their high diffusibility, stemming from relatively lower technical barriers and strong commercial drivers, often limits the duration of any initial strategic advantage gained by early adopters.

In contrast, Weaponization describes the process applied to technologies with low dual-use potential, where the core technical principles are directly converted into novel weapons systems or capabilities that confer absolute, generational advantages in destructive power or strategic coercion. This mode is defined by purpose-driven development exclusively for military ends (e.g., harnessing nuclear fission for atomic bombs), resulting in the generation of decisive "hard power". The Weaponization process is inherently monopolized by state actors due to its exceptional complexity, high resource requirements, and stringent security constraints. This state control creates significant barriers to diffusion, enabling the possessor to establish and sustain profound asymmetric military advantages that can directly and decisively alter conflict outcomes.

The critical distinction between these modes lies in their mechanism of military impact generation and the nature of the capability gap they produce. Militarization enhances a military's effectiveness indirectly through system-wide optimization, creating advantages that are often incremental and transient due to technological diffusibility (Horowitz, 2018). Weaponization, conversely, generates direct and existential military effects through transformative capabilities, creating capability gaps that are deep and enduring due to technological exclusivity and state monopolization. This bifurcation underpins the divergent pathways through which advanced technologies ultimately influence warfare and international relations.

Systemic Enablement Effect or Existential Determinacy Impact

The military application of advanced technologies fundamentally transforms warfare through distinct pathways determined by their mode of application (Militarization or Weaponization), generating either Systemic Enablement Effects or Existential Determinacy Impacts. This influence manifests across two critical dimensions: war outcomes and the character of war (encompassing intensity, societal significance, and political utility).

Technologies undergoing Militarization, exemplified by railways, primarily exert Systemic Enablement Effects by indirectly enhancing military capabilities such as logistics, mobilization, and command efficiency. While initial adopters may gain temporary operational advantages—as Prussia demonstrated through rapid mobilization in the Austro-Prussian War—the high dual-use potential inherent in such technologies facilitates rapid diffusion, eroding early-mover advantages and preventing decisive strategic outcomes, evidenced by railways transitioning from facilitators of Prussian victory to sustainers of the WWI stalemate. Regarding war character, Militarization enables total war by facilitating mass societal mobilization and resource coordination, expanding conflict scale and elevating war's societal centrality. This process subtly shifts war's role from a political instrument toward an autonomous force capable of dominating national priorities, a transformation accelerated by railways alongside complementary technologies like telegraphs and internal combustion engines, as noted by Van Creveld (2010).

In contrast, technologies adapted through Weaponization, typified by nuclear arms, produce Existential Determinacy Impacts via direct conversion of technical characters into unprecedented destructive capabilities. This directly dictates war outcomes by creating absolute, generational capability gaps; nuclear weapons abruptly terminated WWII by shattering Japanese resolve and deterring Soviet geopolitical ambitions, their technological complexity and state monopolization ensuring durable asymmetric advantages. More profoundly, Weaponization redefines war character by bifurcating conflict into conventional and nuclear realms, imposing an existential threshold through Mutual Assured Destruction (MAD) (Jervis, 1989). MAD drastically diminishes the strategic value of conventional superiority, compels extreme statecraft caution due to catastrophic escalation risks, and renders large-scale nuclear war politically unacceptable, thereby restoring primacy to diplomacy and deterrence. Consequently, Systemic Enablement optimizes warfare within existing paradigms, amplifying scale but offering incremental influence, while Existential Determinacy transcends paradigms, decisively terminating conflicts and revolutionizing war's feasibility and political logic.

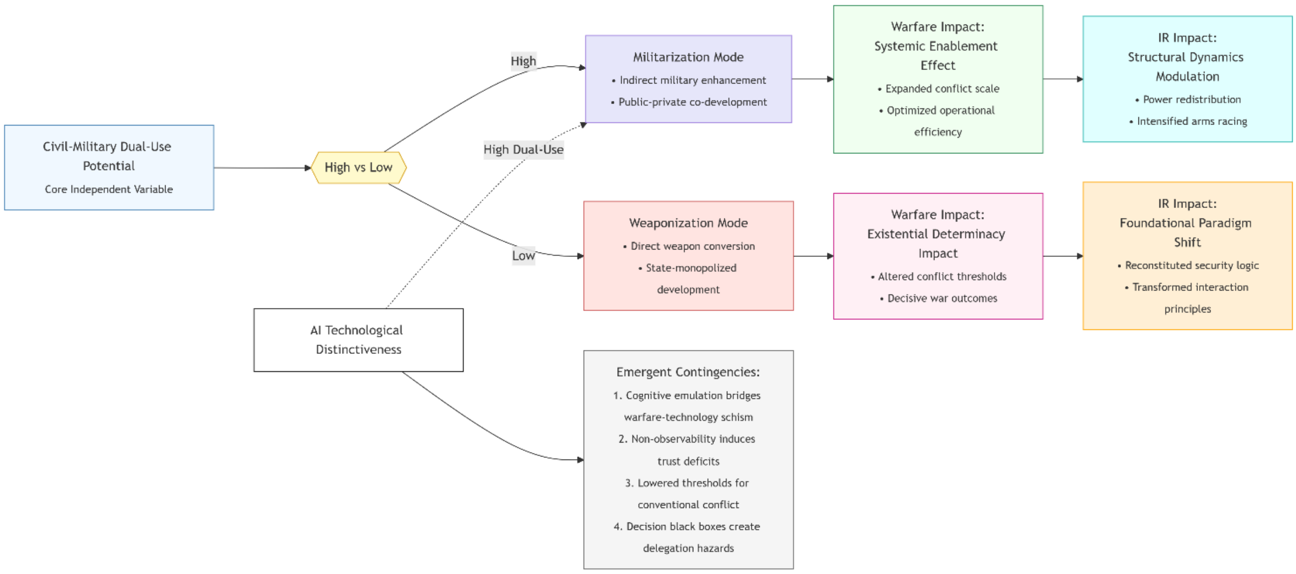
Structural Dynamics Modulation or Foundational Paradigm Shift

The military application of advanced technologies exerts divergent influences on international relations, operating across two interconnected strata: the distribution of power among states and the fundamental principles governing interstate behavior. While shifts in relative power represent a more immediate and variable dimension, transformations in the foundational logic of international relations constitute deeper, structural change. Crucially, the application mode (Militarization or Weaponization) determines whether this influence manifests as Structural Dynamics Modulation or Foundational Paradigm Shift.

Technologies adapted through Militarization, such as railways, generate Structural Dynamics Modulation. This process temporarily alters the distribution of power by enabling states to enhance military capabilities, thereby creating short-term power asymmetries. Prussia's victory over Austria, facilitated by superior railway mobilization and logistics, exemplifies this dynamic modulation of interstate power balances. However, even as Militarization escalates conflict intensity and scale, culminating in the era of total war, it fails to transcend the core tenets of realist international relations. War remains a rational instrument of statecraft, states continue to prioritize relative gains under anarchy, and the fundamental logic of power politics persists. Thus, Militarization modulates the dynamics of the international system – reshuffling power rankings and intensifying security competition – without altering its underlying paradigmatic foundation.

Conversely, technologies adapted through Weaponization, epitomized by nuclear arms, drive a Foundational Paradigm Shift in international relations. This stems directly from their Existential Determinacy Impact on warfare. Mutual Assured Destruction (MAD), arising from mutual vulnerability to nuclear annihilation (Jervis, 1989), fundamentally reconfigures state behavior and systemic logic. Firstly, war loses its viability as a rational policy instrument; victory becomes meaningless when survival itself is jeopardized. Secondly, this existential constraint elevates political management and crisis prevention to paramount importance, fostering a shift toward negotiation, arms control, and strategic trust-building mechanisms.

Figure 1: Analytical Framework for Military Application of Advanced Technologies



Note: Solid arrows indicate deterministic causal pathways empirically validated through historical cases (railways = high dual-use; nuclear = low dual-use). Dashed arrows denote contingent effects arising from AI's technological distinctiveness. Color coding: Blue = antecedent condition, Purple/Red = application mechanisms, Green/Orange = outcome domains, Gray = emergent contingencies.

Consequently, the systemic imperative evolves from relentless power accumulation to the active avoidance of catastrophic conflict. While realist calculations of power endure, they operate within a radically transformed framework where institutionalized cooperation and deterrence logic become essential for survival, reflecting a profound integration of realist and institutionalist imperatives.

AI's Military Turning

Civil-Military Dual Use Nature

The civil-military dual-use potential of AI technology can be assessed through two primary criteria: the original developmental purpose and the dominant actors driving innovation. Historically, computer technology – the foundational infrastructure for AI – emerged from military laboratories during WWII for artillery calculations, exhibiting initial military-centric development. However, its trajectory shifted decisively toward civilian dominance following the commercialization of personal computing in the 1980s and the de-militarization of network infrastructure, which enabled the public Internet. This transition underscores how technologies initially spurred by military needs can evolve toward predominantly socio-economic drivers. AI technology inherits this trajectory; its development has been predominantly propelled by civilian market forces rather than state-directed military imperatives, placing it firmly within the realm of high dual-use potential technologies from its inception.

A critical indicator of dual-use potential lies in the balance of actors shaping technological advancement. Unlike nuclear technology, whose weaponization was exclusively state-monopolized, or even railways which involved state-private partnerships, contemporary AI development is overwhelmingly driven by private commercial entities (e.g., Google, OpenAI) operating within market frameworks (Horowitz et al., 2022). These actors prioritize applications addressing economic efficiency, consumer services, and societal needs. State involvement primarily occurs reactively, seeking to adapt commercially matured AI capabilities for military purposes, rather than directing fundamental R&D. This actor landscape, where innovation originates in the private sector and diffuses outward, is a hallmark of technologies with high civil-military permeability.

Consequently, AI technology exhibits profound structural similarity to railway technology in its dual-use paradigm. Both technologies matured primarily through civilian application, leveraging their inherent practical utility (e.g., data processing, pattern recognition for AI; mass transport for railways). Their subsequent military application emerges not from a primary weapons-design imperative, but from the recognition of their value in enhancing systemic military functions (logistics, decision-making, or resource optimization) through collaboration between states and private entities. This high dual-use potential fundamentally prefigures AI's military application pathway, necessitating analysis through the lens of Militarization rather than Weaponization, and signaling its likely impact profile on warfare and international relations.

Militarilization

The high civil-military dual-use potential of AI technology dictates that its military application manifests primarily as Militarization, a pattern substantiated by theoretical principles and empirical observations. Theoretically, Militarization processes for dual-use technologies exhibit inherent indirectness and graduality. Unlike purpose-built military technologies, AI advancement remains predominantly driven by civilian-sector innovation in machine learning, large language models, and related fields. Consequently, its military integration relies on repurposing existing capabilities rather than developing bespoke weapons systems. This necessitates protracted application phases focused on leveraging AI's practical utility, such as enhancing decision velocity, optimizing logistics, or augmenting ISR (Intelligence, Surveillance, Reconnaissance) efficiency, rather than creating generationally superior "hard" capabilities. As Horowitz (2018) contends, AI functions fundamentally as an enabler, akin to general-purpose technologies (GPTs) like railways or electricity, generating systemic enhancements rather than direct combat power, a trajectory further validated by emerging research (Horowitz & Resnick, 2025).

Structurally, the actor landscape reinforces this Militarization paradigm. Unlike the state monopolization seen in nuclear weaponization, AI development and deployment remain dominated by private entities (e.g., Google, OpenAI). Military application thus occurs through public-private partnerships, creating a structural tension: while commercial dynamism accelerates overall AI progress, it simultaneously complicates defense integration. Governments face significant challenges in governing dual-use diffusion, establishing ethical boundaries, and ensuring reliable control of AI-enabled military systems, introducing operational and strategic uncertainties absent in state-monopolized Weaponization. Empirical analyses confirm AI's Militarization trajectory across functional domains:

Combat enhancement: AI augments existing platforms (e.g., via image recognition in unmanned systems) and cyber operations, creating novel tactical options without generating standalone weapons (Burton & Soare, 2019; Westhues, 2025).

Decision superiority: Integration into C4ISR systems accelerates data processing and course-of-action generation, compressing decision cycles (Johnson, 2019; Trusilo, 2023; Johnson, 2020).

Logistical optimization: Predictive analytics improve resource allocation and sustainment efficiency across operational theaters (Burton & Soare, 2019).

Critically, these applications exploit AI's inherent utility for systemic optimization (enhancing accuracy, speed, or cost-effectiveness), not direct force projection. Even ethical concerns (Nalin & Tripodi, 2023) arise from AI's role in supporting human decisions, not autonomous weaponization. Thus, AI military application demonstrably aligns with Militarization: its core technologies (machine learning, NLP, HCI) enable indirect capability enhancement through integration with existing military systems. This pathway prefigures its impact profile, characterized not by existential deterrence, but by systemic enablement effects reshaping warfare's conduct and scale.

Systemic Enablement Effect

The Militarization of AI technology inherently generates Systemic Enablement Effects on warfare, manifesting through three interconnected dimensions: war outcome influence, shifts in state belligerence calculus, and the recalibration of conventional conflict significance. Regarding war outcomes, AI enhances combat and decision-making system efficiency, creating discernible military capability gaps. While analogous to railways in its enablement logic, AI's greater technical complexity – constrained by hardware scalability (e.g., advanced chips, power infrastructure) and adoption barriers (Horowitz, 2018) – renders its military advantages more pronounced and durable than historical precedents. This complexity impedes rapid diffusion, affording early adopters significant, albeit non-existential, leverage over adversaries.

Concurrently, AI's systemic enhancement lowers thresholds for military engagement. States gaining relative AI-enabled superiority exhibit increased propensity for force employment, driven by two dynamics. Firstly, AI augments strike precision (e.g., via image recognition) and mission efficiency, maximizing tactical gains while minimizing collateral costs. And secondly, integration with unmanned systems (UAVs, robotics) reduces both material losses and domestic political constraints, particularly for democracies facing public casualty sensitivity (Gill, 2019). Consequently, AI erodes the caution imposed by the nuclear age, making limited conflicts instrumentally attractive despite strategic risks.

Most pivotally, AI revitalizes conventional warfare within the nuclear shadow. Where Mutual Vulnerability previously marginalized non-nuclear options, AI now enables "controlled escalation". In our physical world, AI-augmented precision strikes (missiles, drones) offer calibrated force application with reduced escalation risks, fostering illusions of manageable conflict (Johnson, 2024). For the cyber battlefield, AI-enhanced cyber operations create ambiguous, low-attribution attack vectors, lowering perceived retaliation thresholds while complicating crisis stability (Yamin et al., 2021). For instance, Mirsky et al. (2023), on the basis of recognizing that AI technology can enable traditional means of cyber-attack, listed 33 main means of attack, and found 7 most important means of attack, including network vulnerability exploration and attack, attacking social engineering and credential collection, etc. This functional utility transforms conventional warfare from a relic of pre-nuclear strategy to a viable tool within modern deterrence frameworks, not by overcoming nuclear realities, but by exploiting seams beneath the existential threshold.

Thus, AI militarization's systemic enablement intensifies rather than transcends existing war paradigms: amplifying military advantages, lowering conflict initiation barriers, and expanding conventional options, all while operating within the bounded rationality of nuclear deterrence. This warfare-level impact directly modulates subsequent international relations dynamics, necessitating examination of its structural consequences.

Structural Dynamics Modulation

The Militarization of AI technology generates Structural Dynamics Modulation within international relations, by altering power distributions and strategic interactions without transforming the system's foundational logic. This manifests primarily through two interconnected channels: the recalibration of international power structures and the emergence of pan-domain technological competition.

AI's dual-use nature amplifies its geopolitical significance, enabling states to leverage advancements for both military capability enhancement and socio-economic advantage. This dual leverage accelerates shifts in relative power. Major states (notably the U.S., China, and Russia) are engaged in de facto AI supremacy competitions, driven by recognition that AI leadership confers broad strategic advantages. China's explicit ambition to become a global AI superpower by 2030, pursued through military-civil fusion strategies integrating state-owned enterprises (State Council of China, 2017; Kania, 2017), exemplifies this calculus. The U.S. response, including initiatives like the National AI Research Resource (NAIRR) to democratize AI resources and bolster private-sector innovation, reflects countervailing efforts to maintain technological parity. Concurrently, emerging powers (e.g., India, Brazil) and entities like the EU seek positions within this evolving hierarchy, potentially redrawing traditional power maps as AI capabilities diffuse (Polcumpally, 2020). Crucially, these dynamics represent reconfigurations within the existing power-political framework, not its transcendence.

The militarization of AI fuels a pan-domain arms race that transcends traditional military boundaries, generating structural modulation through three mutually reinforcing dynamics: a) societal embeddedness ensures competition remains unbounded, as AI's pervasive civilian value renders technological restrictions politically and economically unsustainable, compelling continuous advancement across economic, technological, and military spheres; b) nuclear entanglement introduces existential risks, with nuclear powers rushing immature AI into command, control, and intelligence (C3I) systems to avoid perceived vulnerabilities, thereby amplifying crisis instability and accident potential (Johnson, 2020); and c) strategic complexity exacerbates pre-existing security dilemmas, including arms control verification in opaque AI-enabled systems and attribution challenges in cyber operations,intensifying great-power friction while operating firmly within realist paradigms of relative gains and anarchic competition.

Consequently, AI militarization modulates the dynamics of international relations: intensifying great-power rivalry, enabling middle-power mobility, and complicating crisis management – yet operating firmly within the enduring paradigm of competitive statecraft. Its impact lies in accelerating and complexifying existing logics, not in forging a new constitutive order as witnessed with nuclear weaponization.

AI's Unique Dilemma

The Logic of Technology and War have been Assimilated

Synthesizing the analytical paradigm, categorized by dual-use potential, application modes (Militarization/Weaponization), and cascading effects on warfare (Systemic Enablement/Existential Determinacy) and international relations (Structural Dynamics Modulation/Foundational Paradigm Shift), AI's military application is characterized as a high dual-use technology undergoing Militarization, exerting Systemic Enablement Effects on conflict and Structural Dynamics Modulation on the international system. Crucially, however, AI's epoch-defining technical distinctiveness transcends this framework: it not only enhances capabilities within existing technological paradigms but pioneers novel intelligent architectures that partially emulate – and potentially diverge from – human cognition. By processing data through self-optimizing neural networks, AI generates operational logics that may remain opaque or inconsistent with human reasoning. This capacity to simulate cognitive processes initiates a fundamental shift: the reconciliation of technology's linear determinism with warfare's inherent unpredictability.

Historically, a profound epistemological schism separated technological and martial logics. Technology operates through linear, rule-bound causality grounded in physical laws; warfare thrives on ambiguity, deception, and emergent chaos resistant to deterministic modeling (Van Creveld, 2010). This schism constrained technology's strategic impact: while enhancing tactical efficiency (e.g., railways for mobilization, computers for fire control), it could not penetrate war's existential core governed by human intuition, political will, and organizational dynamics (Biddle, 2006; Boot, 2006;

Black, 2013). Consequently, technological superiority alone rarely dictated conflict outcomes, often necessitating synergistic organizational innovation (Horowitz, 2010).

AI bridges this schism by simulating human cognition within technological systems. Its evolution occurs through two transformative phases. Machine Learning, statistical inference from data enables pattern recognition and predictive analytics, transcending pre-programmed instructions; Neural Networks, emulating biological cognition through adaptive, weighted node architectures that self-optimize toward solutions. This synthesis of computational power and cognitive emulation produces quasi-autonomous reasoning, capable of navigating ambiguous scenarios in ways that begin to approximate, yet potentially exceed, human contextual understanding.

Thereby, AI fundamentally reconfigures the technology-war nexus: its logic is no longer alien to warfare's essence but cognitively convergent with it. Unlike prior technologies that externally augmented military functions, AI internally assimilates warfare's core logic by handling uncertainty, adapting to deception, and generating non-linear solutions. This convergence enables deeper integration into strategic decision-making, not merely as a tool but as a co-constituent of martial rationality. As the epistemological divide narrows, technology transitions from a supporting variable to a central determinant in conflict dynamics, potentially rivaling human agency in shaping war's conduct and outcomes. This paradigm warrants rigorous examination of AI's emergent agency and its implications for human control.

Negotiation Challenges

The inherent dual-use permeability and virtual embeddedness of AI technology fundamentally reconfigure the dynamics of great-power arms racing, generating structural constraints on arms control while exacerbating international trust deficits. Unlike traditional military competitions centered on discrete weapon systems, the AI arms race permeates civilian and military domains simultaneously, rendering technological supremacy indispensable for comprehensive national power. This indivisibility ensures relentless advancement, as no state can afford lagging in foundational AI capabilities that undergird economic competitiveness, military effectiveness, and cultural influence (Hunter et al., 2021). Crucially, AI's unique technical attributes (its non-observable development cycles and civilian innovation dominance) introduce novel security dilemmas that resist conventional confidence-building mechanisms.

The virtualization of AI capabilities creates an asymmetric transparency trap. Whereas nuclear arms races permitted mutual verification through physical monitoring (e.g., satellite reconnaissance of missile silos, test ban seismic signatures), AI development occurs within opaque digital ecosystems.

Adversaries cannot reliably discern research priorities, algorithmic breakthroughs, or military integration thresholds until operational deployment, often signaled only through cyber offensives or autonomous weapon engagements. This perpetual "fog of peacetime" amplifies risk perceptions, as states must assume worst-case capabilities in rivals' undisclosed AI programs. Consequently, the trust scaffolding that stabilized nuclear competition (based on verifiable deployments and predictable escalation ladders) collapses, replaced by preemptive arming spirals fueled by reciprocal threat inflation.

Simultaneously, AI's socio-technical embeddedness precludes effective militarization constraints. Private sector primacy in AI innovation subordinates defense applications to commercial imperatives. Restricting military application would require stifling the civilian ecosystem that drives economic growth, a politically untenable trade-off democracies cannot sustain. Moreover, attempts to bifurcate "civilian" and "military" AI fail technically: identical machine learning models optimize supply chains and target acquisition; computer vision algorithms enhance medical imaging and missile guidance. This functional fungibility ensures arms control proposals face insurmountable societal resistance, perceived as threats to technological sovereignty and economic welfare.

The confluence of these factors (unverifiable advancement and irreversible dual-use integration) forges a self-reinforcing vicious cycle: uncertainty breeds suspicion, triggering deeper investments in opaque capabilities, which further erodes trust. Unlike the managed stability of nuclear deterrence, the AI-security dilemma lacks institutional or technical circuit-breakers, relentlessly intensifying systemic friction while foreclosing diplomatic off-ramps. Herein lies the tragic paradox: the technology most capable of optimizing human welfare becomes the catalyst for its gravest strategic instabilities.

The Change in a Nation's Attitude towards War in the Nuclear Age

The military application of AI technology fundamentally recalibrates state calculus regarding conventional conflict under nuclear deterrence paradigms. By systemically enhancing military capabilities through precision targeting, unmanned platform integration, and cyber warfare augmentation, AI reduces both material costs and political risks associated with force employment. This dual reduction erodes the caution historically imposed by mutual vulnerability: when combined with the asymmetric capability, on military and other social factors, derived from AI's technical complexity (where hardware dependencies and algorithmic sophistication create enduring advantages resistant to rapid diffusion), states gain increased confidence in leveraging limited military options. Consequently, nations possessing AI-enabled superiority exhibit heightened propensity for offensive action to secure interests, effectively revitalizing conventional warfare as a politically viable instrument within the nuclear threshold.

This resurgence of conventional utility directly challenges the nuclear taboo, the normative restraint that marginalized large-scale interstate conflict post-1945. By making calibrated escalation appear controllable and politically sustainable (particularly through unmanned systems mitigating public casualty sensitivity), AI incentivizes risk-taking that could breach deterrence firebreaks. As Lieber & Press (2006) anticipated, such technological enablers corrode crisis stability by increasing the perceived feasibility of limited wars, a dynamic acutely manifested when AI lowers the psychological and material barriers to initiating violence under nuclear deterrence.

Compounding this instability, AI's integration into decision architectures introduces novel escalation pathways. Within conventional command systems, AI's reliance on historical training data entrenches cognitive path dependencies, institutionalizing strategic biases and reducing adaptive flexibility during crises. More critically, embedding AI within nuclear command, control, and communications (NC3) systems merges two existential uncertainties: the opacity of machine reasoning and the catastrophic consequences of nuclear employment. This convergence creates a double-blind dilemma: human operators cannot fully anticipate AI-driven recommendations, while adversaries cannot discern whether actions originate from human or algorithmic deliberation. The resulting erosion of predictability and intentionality undermines decades of carefully constructed signaling protocols and shared escalation understandings. When state behavior becomes untethered from rational-actor assumptions, and when critical decisions may reflect non-interpretable machine logic rather than politically accountable judgment, the foundational trust sustaining deterrence erodes, potentially triggering preemptive actions based on worst-case interpretations of ambiguous events. Herein lies the tragic paradox: a technology designed to optimize decisions may ultimately render them irredeemably unstable at the precise moments demanding utmost clarity.

Conclusion

War, as the most intense manifestation of interstate interaction, invariably exerts transformative effects on international relations, reshaping power distributions, geopolitical landscapes, and the constitutive logics of global order, irrespective of its scale or duration. Given war's pivotal role, any factor modulating its conduct, outcomes, or existential character (whether diplomatic, economic, or domestic-political) indirectly reconfigures international relations through this bellicose prism. Among these factors, technology occupies an increasingly central position in modern statecraft. As societies modernize, technological advancement emerges as a co-equal driver of historical development alongside traditional forces like social organization, religious culture, and political institutions. This elevated status accelerates technological innovation while intensifying state efforts to harness advanced technologies for military advantage.

This article has constructed a comparative-historical framework to analyze how distinct technologies differentially shape warfare and its international repercussions; examining railway and nuclear technologies through qualitative analysis reveals that civil-military dual-use potential constitutes the foundational determinant of military application pathways – where high dual-use enables Militarization (systemic enhancement of military functions) while low dual-use drives Weaponization (direct transformation into existential capabilities). These application modes generate divergent war impacts: Militarization produces Systemic Enablement Effects that optimize warfare within prevailing paradigms, whereas Weaponization yields Existential Determinacy Impacts fundamentally altering conflict thresholds and outcomes. Consequently, their international relations implications bifurcate, as Militarization modulates Structural Dynamics by reconfiguring power balances within existing norms, while Weaponization catalyzes Foundational Paradigm Shifts transcending established interstate logics.

Applying this paradigm to AI technology, a quintessential high dual-use technology, confirms its trajectory toward Militarization. Empirical and theoretical evidence consistently demonstrates AI's role in systemically enhancing military efficiency (e.g., decision acceleration, precision strike augmentation, unmanned systems integration) rather than creating standalone weapon systems. Consequently, its primary influences align with Systemic Enablement Effects on warfare and Structural Dynamics Modulation in international relations, intensifying arms racing, recalibrating power hierarchies, and exacerbating security dilemmas without transcending realist interstate logics.

Beyond this classification, however, AI's epochal distinctiveness introduces unique contingencies: its capacity to simulate human cognition bridges the historical epistemological schism between technological determinism and martial unpredictability, potentially elevating technology to co-constitutive status in strategic decision-making; concurrently, virtual embeddedness and socio-technical diffusion generate novel trust pathologies wherein development non-observability fuels mutual suspicion while civilian innovation dominance obstructs arms control; further amplified by AI's role in lowering thresholds for conventional engagement under nuclear overhaws, enabling controlled escalation fantasies that corrode deterrence stability, and critically, its integration into decision architectures (especially nuclear command systems) creates double-blind delegation hazards that erode crisis predictability and accountability.

This study's principal contribution lies in establishing a generalizable framework linking dual-use potential to military application typologies and their cascading geopolitical effects. Limitations warrant acknowledgment: the historical sample size (railway/nuclear technologies) necessitates validation through additional cases; the AI analysis remains partially conjectural absent large-scale combat evidence; and quantitative metrics for dual-use thresholds require refinement. Nevertheless, as humanity transitions from the information age to an intelligence revolution, AI's military assimilation represents not an endpoint but an iterative cascade, one whose systemic effects will deepen with each technical leap. For international relations, already navigating resurgent great-power rivalry, AI militarization functions as a catalytic accelerant: amplifying competitive dynamics, complicating crisis management, and challenging institutional resilience. While promising societal advancement, its martial application demands vigilant statecraft; lest the quest for strategic advantage inadvertently forges new vulnerabilities from the very tools designed to master uncertainty

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