Contemporary Education Frontiers, 2026, Volume 4, Issue 7
https://bbwpublisher.com/journal/CEF
Online ISSN: 3029-1860
Print ISSN: 3029-1879

Research on the Construction of Wargame Culture in the New Era Based on War Mechanisms and Scientific Cognition

Fang Zhang, Yanan Lei, Yingxin Duan

Rocket Force University of Engineering, Xi'an 710025, Shaanxi, China

Copyright: © 2026 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: The construction of wargame culture should take compliance with the objective mechanisms of war as its fundamental principle, mathematical-quantitative analysis as its foundational method, bilateral autonomous adversarial engagement as its practical form, and dialectical after-action review and iteration as its cognitive advancement path. It constitutes a distinctive military cultural paradigm that embodies scientific military thinking, integrates the science of command with the art of command, and facilitates the pre-practice of war. With the steady advancement of wargaming applications, the cultivation of wargame culture should fully unleash the core value of wargames in exploring the laws of war, validating tactical concepts, and shaping decision-making thinking, thereby providing cultural foundations for the transition of military training and preparedness from an experience-based judgment paradigm to a scientific operations research paradigm.

Keywords: Wargame culture; War mechanisms; Scientific quantification; Adversarial gaming; Dialectical cognition; Science of command; Art of command; Realistic training

Online publication: July 26, 2026

1. Introduction

The history of wargaming can be traced back approximately 4,500 years, when the Chinese began using stones and wooden sticks on the ground to demonstrate formations and study warfare. China is the only nation to have classified chess manuals as military treatises; in the Northern Song dynasty, the Thirteen Chapters on Chess resonated with Sun Tzu' s Thirteen Chapters on the Art of War and among the "four arts of the Chinese scholar" (qin, qi, shu, hua), chess was regarded as a tool for cognitive training rather than a toy. The modern form of wargame was invented in 1811 by the Prussian court war counselor von Reisswitz. Over the following two centuries, wargaming repeatedly demonstrated its predictive value in major wars—from the Russian wargame in 1914 that exposed the fatal flaws of the two-front offensive at the Battle of Tannenberg but was ignored, to German Karl Dönitz's validation of "wolfpack tactics" through wargaming in the winter of 1938–39, to the U.S. military's rapid completion of the "Desert Shield" plan wargaming using a commercial board

game in 1990. Wargaming is not about reproducing a war, but about capturing the core elements of war and inspiring people to master the art of warfare. It is through this long accumulation of practice that a wargame culture gradually took shape, characterized by mechanism adherence, scientific quantification, adversarial gaming, and dialectical cognition.

The essential characteristic of wargaming lies in its reliance on models to reconstruct the relational connections among combat elements, on rules to constrain the boundaries of combat actions, on red-blue interaction to simulate offense-defense gameplay, and on after-action review discussions to reflect on cognitive biases. It is a scientific practice aimed at exploring the laws of war. The wargaming process is simultaneously one of applying the science of command to calculate advantages and disadvantages and to plan deployments, and one of exercising the art of command to make adaptive decisions and achieve surprise. The values, modes of thinking, operational norms, and research ethos gradually formed during this process collectively constitute wargame culture [1].

2. Defining the connotation of wargame culture

Understanding wargame culture requires first clarifying the essential distinction between wargaming and general military simulation. Models, simulations, and wargaming constitute a bottom-up dimensional escalation: the essence of a model is "quantification"—reproducing entities through parameters such as scale; a static model made dynamic becomes a simulation, whose essence is "probability-seeking"—deriving probability distributions through computation; when humans employ these probabilities for adversarial decision-making, it ascends to wargaming, whose essence is "human involvement." Simulation is mathematical computation and cannot change thinking; wargaming requires human thought and live adversarial engagement to be truly worthy of the name. This hierarchical distinction constitutes the theoretical cornerstone that differentiates wargame culture from general simulation culture.

Furthermore, wargaming does not exist in isolation but forms a complete operational simulation loop together with operations research and military exercises: military exercises focus on action, providing the actual capabilities of forces; operations research translates force capabilities and operational environments into data; wargaming focuses on decisions, adjudicating both sides' command decisions based on operational laws and data, with decision outcomes in turn providing the basis for force actions. These three elements interact cyclically, jointly supporting the exploration and practice of the laws of war [2].

2.1. Mechanism adherence: Compliance with the objective laws of war

Respecting and reproducing the inherent mechanisms of war is the essence of wargaming and the fundamental prerequisite for the emergence and persistence of wargame culture. War mechanisms encompass the objective laws governing the linkage of combat elements, the constraints of spatial-temporal conditions, the attrition of system capabilities, and the balancing of offensive and defensive actions—laws that operate independently of subjective human will. Wargame culture advocates that all wargame design, action handling, and situational assessment should conform to authentic combat logic.

On one hand, adherence to system linkage mechanisms requires coordinating the mutual constraints and supporting relationships among combat chains, including reconnaissance, command, strike, and logistics, while discarding idealized combat assumptions detached from systemic support. On the other hand,

adherence to objective condition mechanisms requires setting action permissions in accordance with actual conditions such as movement ranges, weapon engagement boundaries, and battlefield environmental effects, thereby precluding combat behaviors that violate physical rules and tactical common sense. Simultaneously, adherence to attrition evolution mechanisms requires objectively representing the dynamic changes in personnel, equipment, and system capabilities during the combat process, avoiding unrealistic wargaming settings such as zero losses or zero failures, and fostering a basic research ethos of reverence for its laws and alignment with real combat. Therefore, wargame culture represents the foundational basis for the implementation of the science of command and delineates the reasonable boundaries within which the art of command may be exercised.

2.2. Scientific quantification: Operations research analysis based on mathematical methods

Quantitative analysis is the defining characteristic that distinguishes modern wargaming from traditional strategic discourse. It serves not only as an important support for enhancing the scientific rigor of combat decision-making but also constitutes the scientific quantification attribute of wargame culture. This attribute reflects the principle that research into war mechanisms should primarily employ mathematical thinking to decompose operational problems, transforming force allocation, action sequencing, resource distribution, and risk factors into comparable and weighable analytical objects, and relying on relational connections among elements to judge the effectiveness of actions.

For example, during the plan selection phase, one compares the applicable conditions and potential shortcomings of different force employment modes and coordination methods. During the situational assessment phase, one organizes the scope of impact and trends of change brought by various battlefield variables. During the effectiveness evaluation phase, one comprehensively weighs action benefits against cost in conjunction with mission objectives. The entire process is grounded in objective relational analysis, employing quantitative thinking to reduce subjective judgment bias, thereby constituting the core support of the science of command and providing a rational foundation for the application of battlefield stratagems [3].

It should also be clearly recognized that the logic of wargaming emphasizes approximate calculation; its strength lies in macro-level comprehensive analysis, but it remains deficient in detailed analysis of specific problems. Wargaming relies on historical combat data and training experiment data, using event probabilities derived from battle histories to correct rules—once data precision is insufficient, erroneous conclusions result. Therefore, scientific quantification does not pursue absolute precision but rather approximate calculation to assist decision-making. More importantly, all truly valuable gaming must be built upon both sides' sense of loss aversion toward decision consequences comparable to reality—no matter how exquisite the calculation, if divorced from genuine perception of risk and cost, it remains distorted. The quantitative thinking advocated by wargame culture is the rational foundation for "calculated risk-taking," not a form of tool worship that reduces all war problems to mathematical models.

2.3. Adversarial gaming: Integrating the science and art of command through bilateral interaction

Adversarial gaming is the fundamental presentation form of wargaming and the core vehicle for integrating the science of command and refining the art of command, thereby forming the realistic adversarial concept inherent in wargame culture. War is a dynamic process in which opposing sides actively scheme, mutually

constrain, and continuously adjust strategies; there exist no fixed operational procedures or predetermined outcomes, and decision-making behavior consistently exhibits both rule-bound constraint and battlefield creativity.

Wargame culture upholds the concept of realistic confrontation, insisting that red and blue sides think independently and make autonomous decisions. The science of command is manifested in the formulation of basic operational plans strictly based on battlefield rules, force effectiveness, and systemic logic, with standardized and refined operations research ensuring the steady advancement of actions. The art of command is manifested in the flexible adjustment of deployments, transformation of tactics, and seizing of combat opportunities within the rule framework, employing creative responses to break through gaming stalemates. During the wargaming process, complex situations and unexpected contingencies are proactively introduced to simulate various types of battlefield uncertainties, breaking the rigid mode of script-driven progression and predetermined conclusions. Through sustained offensive-defensive balancing, personnel simultaneously temper their science-based command capabilities and cultivate their strategic art of adaptive response, achieving complementary coordination between the two.

It must be particularly emphasized that the core of wargame adversarial gaming lies in the "human" factor. Battlefield decisions are not pure probability calculations but comprehensive games saturated with psychological pressure, information fog, decision-making time constraints, and marginal cost effects. If traditional tactical-level wargames over-rely on mathematical probability computation while neglecting the psychological state of participants, the construction cost of command chains, and the interference of battlefield contingencies on plan execution, they easily fall into a "precision calculation trap"—deployments that appear seamless on paper may prove ineffective in practice. Therefore, the adversarial concept advocated by wargame culture is not merely the coordination of the science and art of command, but a profound respect for the human factor in war—placing human judgment, willpower, and adaptability at the core of wargaming.

2.4. Dialectical cognition: Promoting continuous cognitive iteration through after-action review

Dialectically examining wargaming results and progressively delving into root causes constitutes the higher-order connotation through which wargame culture achieves cognitive upgrading. A single wargaming run is influenced by multiple factors, including the starting situation, random events, and on-the-spot decisions; victory or defeat holds only reference value and cannot be directly equated with the quality of tactics or the level of competence. Wargame culture advocates rational evaluation of wargaming outcomes, refraining from drawing definitive conclusions based on a single win or loss.

The after-action review phase moves beyond superficial error correction to simultaneously analyze two dimensions: first, the effectiveness of science-of-command application, verifying whether plan calculations, system coordination, and resource allocation conform to objective laws; second, the degree of art-of-command expression, evaluating whether adaptive decisions, tactical innovations, and opportunity seizure align with battlefield reality. Maintaining an open and truth-seeking attitude, personnel objectively examine inherent combat experience, summarize the applicable scenarios for both scientific decision-making and artistic adaptability, and, through multiple wargaming runs across multiple scenarios for mutual corroboration, correct one-sided perceptions, refine methods, and form a cognitive enhancement loop of hypothesis-testing, validation-reflection, and optimization-refinement [4].

In terms of evaluation methodology, a hierarchical progression from data to qualitative analysis to essential patterns should be reflected. First, consolidate the quantitative foundation, focusing on force and equipment attrition, spatial-temporal scope, action effectiveness, and mission accomplishment. Second, focus on dynamic adaptability, emphasizing qualitative assessment of command decisions and operational actions, examining the quality of decision-making under conditions of incomplete information rather than simply judging by "win or loss." Third, mine the essential value, targeting cognition of the laws of war, extracting victory mechanisms and reflecting on shortcomings in operational thinking at the macro-strategic level. Methodologically, combine static and dynamic approaches: use static assessment ("element decomposition + threshold prediction") to establish baseline references; use dynamic assessment ("process tracking + node evaluation") to capture the wargaming evolution trajectory; use comparative assessment ("seeking differences within similarities and similarities within differences") to conduct multiple parallel wargames with varied key variables, stripping away contingent factors to reveal underlying patterns. After-action review is not merely error correction but cognitive iteration—from simulating the "form" to insight into the "spirit," elevating operational thinking [5].

3. Construction pathways for wargame culture

Following the basic laws of military science and aligning with actual training realities, avoiding the design of artificial experiments or fabricated metrics, construction pathways are built around four directions—mechanism, quantification, adversarial gaming, and cognition—while simultaneously coordinating the collaborative development of the science and art of command. It must also be clearly recognized that the essence of wargaming is a tool, not a panacea; its positioning is auxiliary—assisting decision-making, assisting instruction, assisting research, and assisting training. Wargaming cannot escape limited probability, and the contingent risk of divergence from real outcomes always exists. The design of construction pathways should always maintain awareness of this applicable boundary, maximizing strengths while minimizing weaknesses, and avoiding both blind worship and dismissive neglect [6].

3.1. Anchoring to objective war mechanisms: Consolidating the dual-attribute foundation of command decision-making

The inherent laws of war should consistently govern all aspects of wargaming. First, strict control over wargame design is essential: battlefield scenarios, element configurations, and action rules should all be set according to realistic combat standards, fully reflecting objective characteristics such as systemic support, condition constraints, and dynamic attrition, while minimizing artificial idealized settings. Second, regular study of operational mechanisms should be conducted to clarify the internal logic of various combat actions and define the boundaries of rule constraints, ensuring that the science of command has a basis to rely upon and the art of command operates within proper limits. Third, a mechanism verification system should be established to identify ideas and behaviors that deviate from realistic combat mechanisms, ensuring that wargaming can authentically reflect the operational characteristics of war and laying a solid foundation for the coordinated application of both command approaches.

3.2. Popularizing scientific quantitative thinking: Strengthening the core support of the science of command

Mathematical analytical thinking should be integrated throughout the entire wargaming planning process.

Moving away from the habit of relying solely on experiential judgment, personnel should be guided to decompose complex operational problems and organize the relational connections among core elements such as forces, time, space, and logistics. In plan comparison, risk assessment, and effectiveness evaluation phases, advantages and disadvantages should be weighed based on objective conditions, distinguishing the strengths, weaknesses, and applicable scenarios of different strategies. Systematic analysis should replace vague subjective judgment; element-correlation logic should assist in decision-making trade-offs; and precise quantification should solidify the foundation of the science of command, preventing on-the-spot stratagems from becoming detached from their practical basis.

3.3. Strengthening autonomous adversarial gaming: Coordinating the collaborative development of the science and art of command

Restoring authentic offensive-defensive characteristics requires balancing both command capabilities within dynamic gaming. Relatively independent red-blue wargaming groups should be established, with both sides formulating basic deployments based on rules and computational conclusions, thereby maintaining the fundamental baseline of the science of command. Building upon this, personnel should be encouraged to flexibly adjust tactics in response to changing battlefield situations, seize offensive-defensive windows, and innovate response methods, thereby appropriately exercising the value of the art of command. Unexpected battlefield conditions should be reasonably introduced to break fixed wargaming procedures, guiding participants to distinguish scenario attributes: stable situations emphasize scientific coordination for situational control, while crises emphasize artistic decision-making for breakthrough—avoiding both mechanical dogmatism and blind impulsiveness, and achieving organic unity between rule-based operations research and flexible adaptability.

3.4. Establishing dialectical cognitive concepts: Building an iterative reflection culture for dual decision-making capabilities

The perception of wargaming value should be rectified, and the after-action review and improvement mechanism should be perfected. Outcomes of engagements should be evaluated objectively, with wargaming effectiveness judged comprehensively based on situational conditions, the decision-making process, and the degree of mission accomplishment, discarding the one-sided standard of judging solely by wins and losses. The depth of after-action review discussions should be deepened, reviewing both science-of-command content such as plan formulation and resource allocation, and art-of-command content such as opportunity seizing and tactical adaptability, while summarizing the appropriate balance between the two under different battlefield conditions. A wargaming experience compilation and consolidation mechanism should be established to generalize the patterns of scientific operations research and strategic innovation, correct application biases, and transform the gains from individual wargaming runs into normalized capability accumulation, achieving continuous advancement of comprehensive command proficiency [7].

4. Fostering the atmosphere of wargame culture

A robust atmosphere is an important guarantee for wargame culture to take root and develop sustainably. The core lies in breaking through insularity, permeating daily practice, strengthening identification, and stimulating self-motivation, building a cultural ecosystem of learning, researching, applying, and comprehending wargames.

4.1. Tiered popularization: Expanding participation coverage

Following the principle of "intensive study by specialists, general training for all," differentiated activities should be designed by tier. Senior command levels emphasize strategic and operational wargaming, practicing decision-making, coordination, and strategic thinking. Staff specialists emphasize tactical planning and quantitative analysis, practicing computation, coordination, and after-action review. Basic units promote manual wargames and simplified games, utilizing training intervals for squad-level adversarial play and case reproduction, lowering the barrier to participation. Wargaming should be incorporated into military training programs and annual assessments, institutionally driving wargaming out of the "second classroom" and into daily training, forming a popularization pattern of "everyone understanding basic rules, specialists capable of planning and wargaming, and skilled personnel conducting after-action review." In terms of promotion methods, a dual-track approach of "manual wargames + computer wargames" may be adopted: manual wargames for cultivating core capabilities, enabling commanders to internalize key data and conduct wargaming without reference to adjudication tables; computer wargames for building a regular sparring platform that lowers participation barriers, cultivating talent through the principle that "a large base naturally produces elite talent."

4.2. Enriching vehicles: Building a cultural transmission matrix

A diverse set of vehicles should be constructed around "mechanism discussion + adversarial experience + case review + exchange and discussion." Wargame discussion rooms and wargaming laboratories should be strengthened to create immersive wargaming environments. Wargame construction and application forums should be held regularly to analyze classic battle cases, review representative engagements, and share decision-making insights. Activities such as "one wargame, one review; one engagement, one summary" should be conducted to transform after-action review results into tactical manuals and decision-making reference points. Wargame knowledge, wargaming updates, and specialist profiles should be disseminated through military networks and public platforms, producing micro-videos and illustrated case studies to tell wargame stories in formats appealing to service members, conveying the value orientation of "sharpening intellect through wargaming, researching combat through wargaming." Commercial off-the-shelf (COTS) wargames, being inexpensive and quick to learn, can serve as "zero-cost force multipliers," encouraging personnel to repeatedly wargame and practice independently during off-duty time, extending learning from the classroom into daily life [8,9].

4.3. Value guidance: Strengthening victory-oriented identification

The core value of wargaming in serving combat preparedness, refining command, and innovating tactics should be emphasized, correcting the utilitarian tendencies of "emphasizing results over effectiveness" and "emphasizing form over reflection." The unique role of wargaming in addressing training shortcomings and promoting training transformation should be publicized, articulating the profound implication that "one more point of precise calculation on the game board means one more point of victory probability on the battlefield." Advanced exemplars of dedicated wargame study and strategic proficiency should be identified and promoted; outstanding wargaming specialists, after-action review experts, and tactical innovation individuals should be recognized, forming a clear orientation of "merit in researching wargames, achievement

in applying wargames, and talent through comprehending wargames." Wargame culture should be integrated with fighting spirit cultivation and honor education, strengthening professional qualities of "striving for victory, rigorous truth-seeking, and coordinated success" during wargaming, and enhancing service members' sense of identification with and belonging to wargame culture [10,11].

4.4. Improving mechanisms: Ensuring sustainable atmosphere development

Supporting mechanisms for organizational leadership, specialist cultivation, activity incentives, and outcome transformation should be established. Responsibility subjects for wargame construction at all levels should be clarified and incorporated into leadership agendas and training evaluations. Professional specialist teams should be strengthened through centralized training, apprenticeship learning, and competition-driven training, cultivating a corps of "wargame instructors" who understand mechanisms, master rules, and are skilled in after-action review. Incentive measures should be improved, linking wargame participation, wargaming quality, and after-action review outcomes with evaluation, promotion, and advancement. Cross-unit exchange mechanisms should be established, organizing regional competitions, joint after-action reviews, and tactical sharing, forming a development pattern of "vertical linkage, horizontal communication, resource sharing, and mutual improvement," driving the sustained growth and long-term viability of wargame culture.

5. Conclusion

The construction and development of wargame culture is essentially the optimization and upgrading of military thinking modes. Its core lies in promoting the transition of war cognition and operational planning from experience-driven to science-driven approaches, while simultaneously achieving the coordinated unity of the normative nature of the science of command and the creative nature of the art of command. In the future, as technologies such as artificial intelligence and big data fully empower wargaming, a hybrid operational wargaming model integrating "rule-based analysis of wargaming with mathematical micro-simulation" may become an important development direction. However, regardless of how technology evolves, the core of wargame culture will always lie in "human involvement"—human thinking, human adversarial engagement, and human decision-making. Only by adhering to this essence can wargame culture maintain its irreplaceable value amid technological transformation.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Tang ZJ, Xu XZ, 2022, Theory and Application of Tactical Wargaming. Ordnance Industry Press, Beijing.

[2] Li JJ, 1998, Military Strategic Thinking (Rev. ed.). Military Science Press, Beijing.

[3] Li MH, 2019, Victory Mechanisms of Intelligent Warfare. Frontline, (02): 2.

[4] Hu XF, Luo P, 2016, Wargaming: Innovation and Practice of Complex System Management. Command Control and Simulation, 38(06): 1–5.

[5] Li H, Xia ZP, 2019, Discussion on the Application of Wargaming. National Defense, (04): 16–18.

[6] Zhang YL, Ni L, Kong WH, et al., 2022, Understanding and Reflection on Practical Wargaming Issues. In Proc. 10th China Command and Control Conference. Beijing.

[7] Fu GM, Zhu K, Jian RG, 2020, Philosophical Reflections on the Balance between Combat Command Art and Engineering. National Defense Technology, (03): 122–126.

[8] Huang YG, Ren FC, 2026, Scientifically Understanding the “Strengths” and “Limitations” of Wargaming. PLA Daily, 2026-03-02.

[9] Fu QY, 2025, Philosophical Reflections and Path Analysis on Wargaming Assessment. PLA Daily, 2025-11-06.

[10] Yang NZ, 2007, Virtual Wargaming: Wargames, Combat Simulation and Modeling. PLA Press, Beijing.

[11] Perla P, 1990, The Art of Wargaming: A Guide for Professionals and Hobbyists. Naval Institute Press, Annapolis.

Publisher’s note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.