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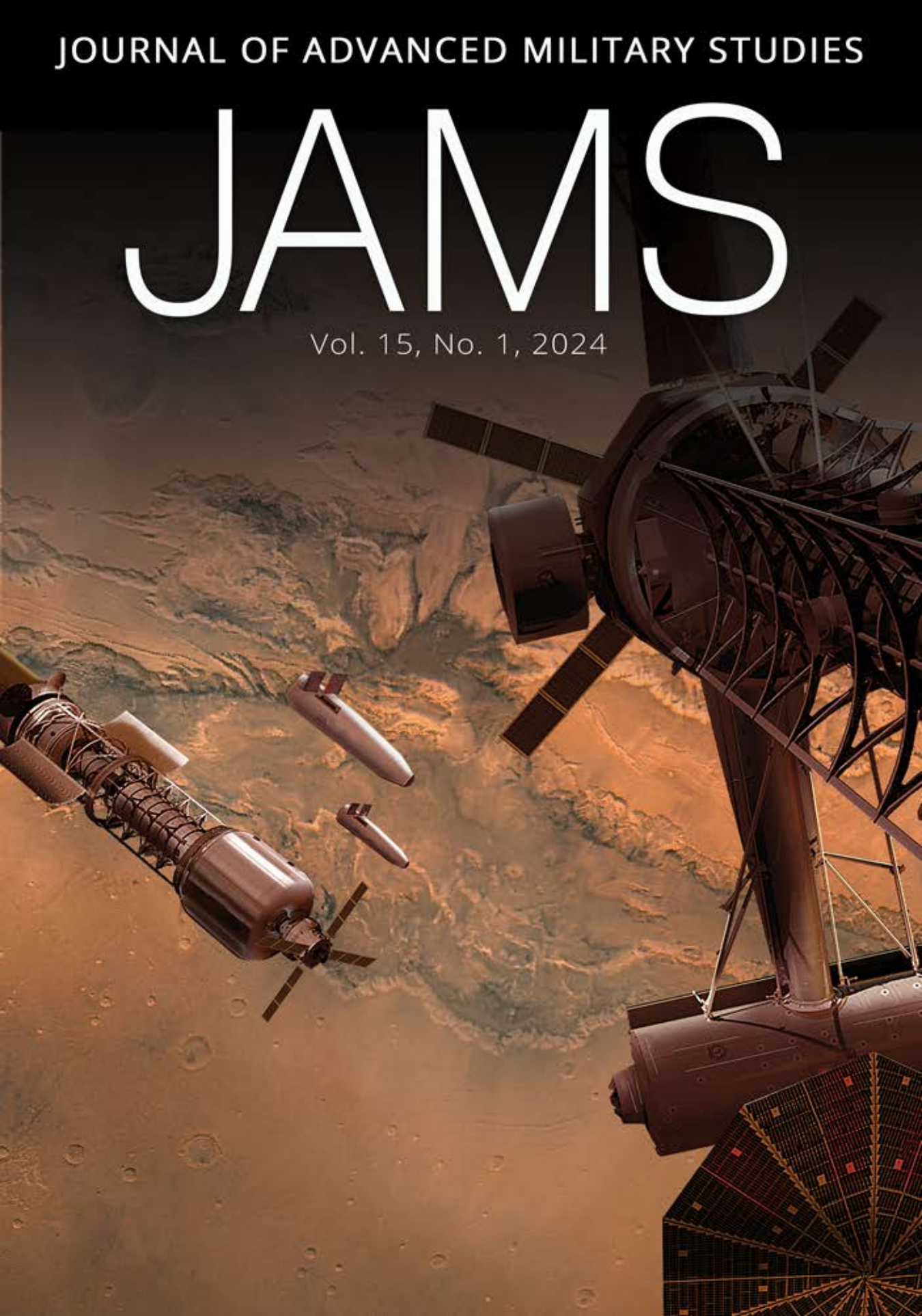

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Breaking the Newtonian Fetish
Conceptualizing War Differently for a Changing World

Ben Zweibelson, PhD

Abstract: Explaining what a military's social paradigm concerning conflict and war is requires a theoretical approach to both frame the core constructs and offer feasible alternatives. This article introduces social paradigm theory for military application and how most modern, technologically advanced militaries sustain a Newtonian-styled worldview concerning warfare and what constitutes war. The Newtonian-styled war paradigm gained prominence during the last five centuries, yet is now becoming increasingly insufficient and possibly irrelevant. The integration of ever-increasingly sophisticated artificial intelligence into nearly all aspects of warfare will require new ways of thinking and how teams of humans and AI systems collaborate in complex security contexts immediately. The new combination of the space domain, cyberspace, those military forces associated with these new domains, and special operations activities are of increased focus for how and why conflict may change, particularly within an overarching traditional nuclear deterrence between state competitors. This requires a military paradigmatic shift, moving away from Newtonian constructs.
Keywords: emergence, complexity, artificial intelligence, warfare, strategy, design

Modern militaries declare without hesitation that war is complex, especially when a conflict features a vast array of actors, intents, and abilities set within a dynamic sea of changing contexts. Militaries, as extensions of nations entangled in competition, cooperation, and conflict are

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called on to secure, defend and, as necessary, inflict organized violence through time and space across multiple domains such as land, sea, air, and now increasingly through what is termed cyberspace and the celestial space encompassing Earth, and beyond. The inhospitable and until recently unreachable space beyond the atmosphere now is teeming with commercial, societal, and military activities, while just in the last few decades Homo sapiens have conjured up an entirely new plane of existence that is virtual, yet increasingly critical for the same commercial, societal, and military activities. Artificial intelligence at the *general* level, capable of matching or exceeding human capabilities in all endeavors, was previously considered a science fiction possibility decades away. At the time of this writing, humanity might be under a decade away, or possibly less than a few years. Applications for artificial intelligence toward all security activities are boundless and likely transformative in ways people struggle to comprehend. Now more than ever, the prospects of future warfare are increasingly complex, dynamic, and elusive. Tomorrow's reality will exercise emergent and unexpected developments unlike anything curated in institutional histories of all the wars of yesterday.

Modern society has no shortage of policy makers, military leaders, or wise strategic sages sounding alarms about the need to think critically, creatively, and incorporate new and different ways of learning so that militaries can fight and win in these complex future security challenges. Yet, there is a paramount disconnect between the calls for change and the response of institutional rigidity, fixation on self-relevance and identity drawn from earlier conflicts, and the modern facet of bureaucratic insulation from real transformation. Before many leaders finish exhaling on the need to innovate and change our ways of thinking in war, they immediately attack anything that does not conform to existing processes, doctrine, or favored practices. Innovation is killed before it gets started within bureaucracies because change is not considered valued if it requires significant destruction and unlearning of what was valued investing in before our system changed so that those values are now obsolete.

If military organizations are asked to drop favorite tools to be able to realize what new, alien tools might emerge that are necessary for tomorrow's challenge, the changes must first occur at the institutional level where one often cannot even question, "why this tool?" If wars of the past did require simpler, Newtonian-based (inspired from earlier Platonic "theory of forms") metaphors for armies and navies to readily understand warfare concepts of those periods, should military institutions continue to extend many of these concepts beyond their value simply because they are well established and familiar? This becomes the foundation for bureaucratic rejection of innovation and new ideas merely because the hand already has a favorite "tool" in use that has a long record of working seemingly well, or well enough for continued self-relevance.[1] By tool, this includes not just the tangible and explicit artifacts employed in warfighting, but the conceptual, abstract, and often tacit things as well. Tacit knowledge is near impossible to convey, but it is what represents deep understanding and

mastery. In other words, one can assemble a bicycle if read instructions over the phone (explicit knowledge), but no one could ever teach a child how to ride a bicycle without training wheels by telling them the finer points of balance over the phone (tacit knowledge).[2]

This article first focuses on the military fixation on Newtonian constructs and how this organizational fetish prevents radically new and transformative constructs from being taken seriously by warfighters. While select terms and models are often plucked from these important emerging areas of human endeavor, they are immediately sanitized, stripped of their meaning, and forced to comply within what might be framed as a Cartesian and Newtonian frame or "style" that rose to dominance in the seventeenth through nineteenth centuries.[3] It is in this fertile period that war "modernized" and militaries of the Middle Ages professionalized through significant changes in education, training, organization, theory, and practice.[4] Yet, despite such change, a surprisingly strong institutional force would preserve many ascientific practices, beliefs, and constructs that continue unimpeded nor seriously examined through today. While some paradoxes and tensions are exposed within the established domains of land, sea, and, more recently, air warfare that have been mastered, it is in the space and cyberspace areas of development as well as the peculiar and exquisite areas of special operations that Newtonian, Cartesian, and even Platonic conceptualization of modern warfare are arguably insufficient as well as oversimplified. Lorraine Daston offers valuable summary:

> Throughout the early modern period, European thinking about natural laws and the laws of nature had evolved in parallel. There were obvious contrasts: natural law held only for human nature and compelled by reason rather than physical necessity; laws of nature could be called such only metaphorically and had to be discovered by empirical inquiry rather than thought experiments about a hypothetical primordial state. Yet their commonalities dwarfed these differences. Both embraced a foundational model in which vast and varied consequences could be derived from a few simple, general laws; both contrasted the universality, uniformity, and immutability of these laws with the mosaic of local customs and local natures.[5]

Innovation takes time and a willingness to challenge not just the institutional status quo but critically consider beyond the very boundaries of what one's shared belief system declares is or is not valuable, relevant, factual, validated, historically proven, and otherwise so well understood that questioning such things seems absurd. General Stanley A. McChrystal and his coauthors addressed this challenge in the book *Team of Teams: New Rules of Engagement for a Complex World.* The title specifies a social reality that is now complex, implying that previous periods of conflict and war in comparison are less complex, or otherwise had narrower cognitive requirements for achieving desired outcomes. This is not merely the ritualized process of updating military doctrine and de-

bating over terminology, or updating a methodology with a new subroutine that otherwise sustains the original logic and belief system concerning war. Social paradigms are representative of how groups of humans believe the world exists, why it is as such, and the ways that one can achieve some harmonious or useful engagement within this reality as we move toward the future and further from the past.[6] McChrystal and his coauthors indicate the military necessity of recognizing what particular social paradigm is employed, the limits therein of what we are conditioned to think and do, and whether we need to break free of such thinking to gain access to what would otherwise be unimagined or unappreciated alternative belief systems. Shifting one's war paradigm requires destruction of existing institutional and individual conceptual barriers, with little to do with actual destruction of physical objects in reality:

> We had to unlearn a great deal of what we thought we knew about how war—and the world—worked. We had to tear down familiar organizational structures and rebuild them along completely different lines, swapping our sturdy architecture for organic fluidity, because it was the only way to confront a rising tide of complex threats.[7]

Although few military leaders and theorists clearly articulate the existence of social paradigms and how military organizations rely upon them for defining what we believe war is (and is not), those advocating this approach tend to use sociology, philosophy, and organizational theory to buttress McChrystal's position that complexity cannot be deciphered using the proven tools that control and manage simplistic and complicated systems.[8] Without starting at a level of abstraction sufficient to comprehend multiple social paradigms where militaries and their respective societies know reality as such, two negative outcomes occur that essentially kill any useful debate. First, operators within their preferred paradigm will deny any value or logical feasibility to concepts that supposedly exist beyond their paradigmatic limits, with operators of different social paradigms holding similar arguments, resulting in both groups talking past one another. This is termed *paradigm incommensurability* and is why military doctrine and institutionalized belief systems cater exclusively to one social paradigm and not others.[9] The second logical failing is that, when confronted with this paradigmatic tension between groups of humans waging war in the same physical reality (while disagreeing through different social realities), an operator of one paradigm will demand that any new concepts or theories must be articulated exclusively using the language and underpinning beliefs and values of their original paradigm. This produces another logical paradox, such as attempting to explain planetary geometry to a flat earther, or how Marxists and democratic, Westphalian capitalists might disagree fundamentally on how and why conflict occurs. We ignore McChrystal's guidance and instead refuse to unlearn, in that the act of unlearning becomes a new form of learning that cannot be guided or controlled by the institutionalized concepts that define what learning and unlearning must be.

In the second part of this article, alternatives to the traditional Newtonian stylization for modern war paradigms are presented. This article challenges the Newtonian physics based, reverse-engineered ends-ways-means and collective rationalization of Cartesian geometric logic found in all military doctrine, models, and methods that otherwise dominate how we understand and decisively act in conflicts. This article will illustrate both of the paradigmatic tensions explained above and illuminate potential pathways that we as humans and future human-machine teams might capitalize on the opening up of new opportunities that are otherwise inaccessible. This is no easy task, and institutional defenders will be ready to chase away such heresy with mobs of pitchforks and flaming torches. People tend to hold to the single, preferred war paradigm at the expense of gaining any new knowledge that also contradicts what is foundational to our belief systems, values, and existing theoretical base of knowledge. Even at our training centers and in our military wargames, performers are evaluated on "how well did you conform to established practices, processes, doctrine, and objective criteria" instead of "might you experiment by violating all institutional norms and preferences by attempting something previously unexamined, unimagined, or unexpected?"[10]

When critically confronted with the cognitive boundaries of our war paradigm and that of potential alternatives, we default once more to demanding these alternative perspectives must adhere to the corresponding beliefs, values, logics, and methods already operating within the dominant worldview on conflict. Modern Western militaries generate doctrine that articulates specific theories, illustrated through certain models and terminology grounded in particular belief systems that otherwise operate invisibly and behind the scenes. By maintaining this, one can neither imagine nor dare to seriously entertain anything that violates this sacred war paradigm. Modern warfare doctrine, methods, and models rigidly adhere to a geometrically styled rendering of warfare, one that remains governed by a Newtonian style of thinking defined below by complexity theorist Haridimos Tsoukas:

> The Newtonian style of thinking operates by constructing an idealized world in the form of an abstract model, in order to approximate the complex behavior of real objects. For example, Newton's laws of motions describe the behavior of bodies in a frictionless vacuum—a mathematically handy approximation, good enough for several real-life occasions. Moreover, the core of the Newtonian style consists of two assumptions. First, the extremal principle; namely, that the objects of study behave in such a way as to optimize the values of certain variables. And, second, prediction is possible by abstracting causal relations from the path-dependence of history.[11]

In the relatively new fields of quantum theory, open systems theory, sociology, complexity theory, as well as postmodern philosophy, there are any number of entirely new ways to conceptualize many of the exceedingly complex and

difficult military concepts of modern warfare that do not support the models and metaphoric constructs dominant in earlier seventeenth century institutionalized habits and patterns. Only in a Newtonian reality could one effectively break something down such as war into universal, enduring principles of war, plan against "centers of gravity," or make the broad claim that "war has an enduring, unchanging nature with a contextually fluid character," as found in all modern doctrine.[12] Newtonian styled reasoning, as applied by the military profession toward complex warfare, seeks the universal, the general, so that outputs accomplish a timeless quality to cast forward on future, unwaged wars a predictive shadow that also spans in reverse so that every historical battle is also in keeping with the constructs. At the ontological level (what is and is not war), war phenomenon, according to this Newtonian worldview, must consist of discrete, objective elements, and their law-like associations expressed can then be identified by a military analyst through a construction of an abstract model. These models are subsequently used for predicting, and, if possible, "controlling the phenomenon at hand. The Newtonian view assumes an *objectivist* ontology, works with a *mechanistic* epistemology [theories of knowledge], and enacts an *instrumental* praxeology [theory and study of human action and conduct]."[13] It is the formation of models and metaphoric devices where militaries engage in what is argued here as a purely Newtonian styled approach to modern warfare, exercised in virtually all doctrine, training, as well as education.[14]

Triangles, trinities, and triads abound today across the Department of Defense just as they did in 1722 when Sébastien Le Prestre de Vauban first published his highly influential book on military fortification, artillery, and geometry for warfare.[15] Vauban was an early and influential military theorist to draw from Newtonian physics to conceptualize military models on what warfare was and how to properly wage it. While modern, complex warfare today demands a flexible, creative, and adaptive military profession to outthink and outperform adversaries, the Newtonian style demotes these so that hierarchy, rigidity, standardization, and uniformity are prioritized—all accomplished through conceptual models reliant upon fixed geometry, systematic logic, and a mathematical approach reliant on laboratory conditions that are best suited for the natural sciences.[16] War in the Age of European Enlightenment became one measured and controlled through scientific endeavors, articulated through the language of mathematics.

Linear, sequential concepts for explaining military affairs, whether in strict logical lines like formulas or recipes, mirroring natural science constructs such as centers of gravity, or arranged in iterative loops such as John R. Boyd's observe, orient, decide, and act (OODA) model, continue to dominate how militaries think and act, as well as think about their thinking. This overdependency on Newtonian styled warfare should be critically challenged, but only through disrupting and challenging the models and metaphoric devices with alternatives. Strange concepts such as a Möbius strip, Klein bottles, and other mathematical metaphors might better support an explanation of complex warfare and

how space, cyberspace, and special operations generate nuanced and different security phenomenon. Further, the integration of sophisticated artificial intelligence with humans provides an expansion in how AI can conceptualize in multiple dimensions differently, yet potentially translate new insights over to the human operator. This teaming could be conceptualized differently if the Newtonian style preferences are tempered, and we begin to play to the cognitive differences and interplay between biologically limited human beings and their artificial counterparts.[17] None of these will come to light unless the institution first realizes what favorite tools they cling to, why they do this, and only then might they deliberately drop some so that they can pick up strange and new ones to experiment with further.[18]

This cannot be accomplished by replacing one manner of graphical representation with another that still must be depicted in two-dimensional space, as humans still largely process these concepts by positioning them as such whether in printed format, on display screens, or other physical manifestation. In other words, replacing ends-ways-means logical arrangements with something such as "successive football plays to get us to the end zone" is merely a metaphoric replacement with the same overarching paradigmatic assumptions remaining in place.[19] Humans comprehend at times in multiple dimensions, but when articulating or communicating to others, our species is most efficient and comfortable working from a two-dimensional plane. However, the contemporary Newtonian styled war paradigm used by most Western, modern organizations does not rely on complexity science or acknowledge war beyond original Newtonian and adjacent constructs designed prior to the twentieth century.[20] Thus, in the arguments leveled below, the modern military as an institution cannot sidestep the problems of only embracing Newtonian constructs by replacing some graphics with non-Newtonian ones, if they still are relying exclusively on the original Newtonian constructs that define the war paradigm from others. To illuminate this challenge, we need to fully explain what social paradigms are and how the modern military currently uses one that rationalizes the perpetual use of Newtonian constructs over others. This will also create new pathways to how and why future human-machine teams with advanced artificial intelligence cannot continue to remain grounded in such outdated and potentially obsolete frameworks.

The Modern War Paradigm and How to Challenge It

When we hear the term *paradigm*, many readers might think of Thomas Kuhn's original treatment of how science progresses through iterations of new paradigms challenging and replacing popular ones that nonetheless are increasingly fragile and problematic.[21] Kuhn specifically addressed science and how he posited it changed through "paradigmatic shifts" that completely transform how reality is understood via science over time. The rise of a Newtonian worldview gradually replaced the earlier feudal and ancient, prescientific frame that contained scientific logic such as astronomy and mathematics, but readily paired

them with astrology, superstition, or alchemy. The Newtonian scientific understanding of the physical world reigned for roughly four to five centuries, but it was replaced in the early twentieth century by both quantum mechanics and the general theory of relativity. This was where our species discovered at the grandest scales down into the smallest particles composing reality, there was not the stability and hierarchical orderliness theorized by natural scientists and most associated with Sir Isaac Newton.

For war, as something entirely designed and exercised by humans against other humans in physical reality, it requires a social reality for which it can manifest that transcends the physical world.[22] Social paradigm theory, produced in sociology for extending Kuhn's original focus on scientific paradigms, posits that a paradigm "offers coherent assumptions regarding how the world should be studied."[23] These are the conceptual worlds where we can think differently about the same phenomena in reality, often in positions that are incommensurate with others operating beyond the paradigm limits that one actor subscribes to while denying alternatives.[24] In premodern periods, societies of humans readily believed that war itself was orchestrated and controlled not by fellow humans, but by deities, spirits, or other external supernatural powers. This does not change the overarching declaration that humanity created and generated the various rationalizations concerning war. Once we as people converge and organize into some definable group that shares certain values and beliefs, we generate and sustain a social paradigm that guides us through an otherwise chaotic, dynamic reality. This occurs whether we are agreeing on social reality with or without science, or whether we converge on a Westphalian, capitalistic system, or that of a Marxist one. Historian Yuval Harari speaks of "imagined order" in this vein:

> We believe in a particular order not because it is objectively true, but because believing in it enables us to cooperate effectively and forge a better society. Imagined orders are not evil conspiracies or useless mirages. Rather, they are the only way large numbers of humans can cooperate effectively.[25]

The external world, the individual internal reality for each of us, and the collectively shared "social" reality we organize to share and maintain also manifests forms of conflict along with the ability to action such violence. All of these forces shape the societal configurations we experience and rely upon to explain why reality is as it seems.[26] Gibson Burrell and Gareth Morgan introduced social paradigms, which thus include any inferences concerning war as another aspect of how humans socialize through competing belief systems.[27] To quickly identify and frame what one social paradigm consists of, and how it will differ from another competing social paradigm, we need to introduce the philosophical terms of ontology and epistemology. Using these concepts, readers can subsequently explore why our modern militaries adhere to a Newtonian stylization

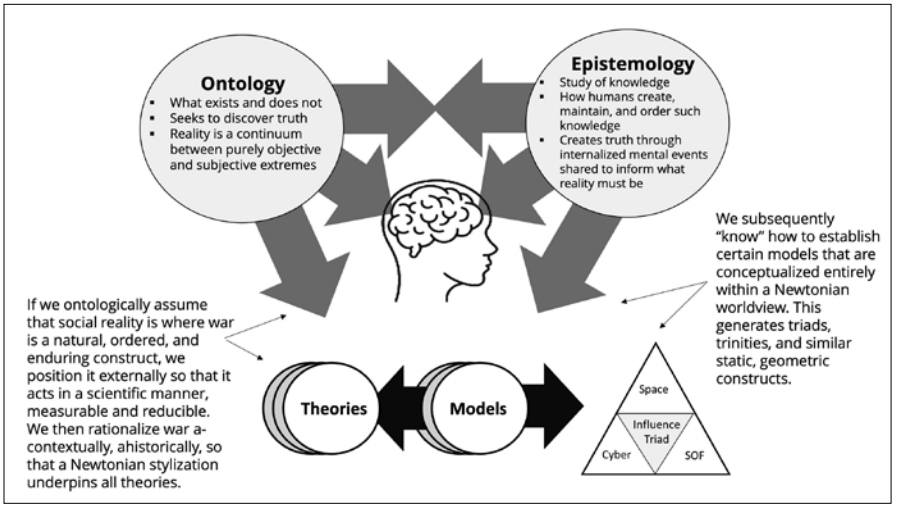
for war and how such a framework intentionally excludes certain things while also making other content inaccessible.[28]

Ontology addresses what people believe is and is not real.[29] Assumptions of reality that are ontological "concern the very essence of the phenomena under investigation" in that the world and what we perceive is us within our heads should be defined in some sort of clear relationship.[30] The accuracy of such constructs is irrelevant here, as humans construct ontologies and hold them in various convictions that are self-serving in maintaining the belief system that created the ontological assumption. For example, people agree on what a table is and is not, despite many different types of tables existing around the world that reflect different cultures, values, geography, and available materials. The abstract and absolute idea of "table" is shared collectively across our minds in an ontological configuration that cannot possibly be realized in a single table found on the planet. No single table possesses all the absolute ideas that "table" encompasses. However, if someone rode an elephant into the classroom and exclaimed, "everyone put their homework here on my table please," the students likely would declare that such a thing was not a table. Ontological assumptions become a collective feedback loop that sustains a certain reality. Actors within that construct use the social paradigm's ontological assumptions to go about their lives and not endlessly have to discover, examine, or question these basic tenets on what is and is not. The world makes sense (enough), and one can then go about the business of living in it, to include how and why to wage war.

While ontology is directly linked to the human experience within complex reality where plants, insects, and animals interact, epistemology is entirely a mental construct that remains in that same continued abstraction for human beings. Epistemology remains in our heads in that it addresses the way we design and curate knowledge itself. It addresses how we attempt to understand phenomena of interest, and how we know the forms and function of such knowledge, while also informing practitioners of a paradigm and subsequently developing that same paradigm via user inputs.[31] Epistemological assumptions work the abstract foundations of knowledge that remain entirely within our collective understandings, passed on to each subsequent generation. If we "know" through our ontology about reality, we also understand how the world is supposed to work within our belief system, even if we rarely take an interest in what that belief system is or how it establishes just as many limitations as it does declarations.

The modern war paradigm hosts many epistemological assumptions concerning war, such as the belief that war can be compartmentalized generally into a hierarchical arrangement of strategic, operational, and tactical levels. Yet, no soldier can point to where the tactical level becomes the operational level on a map or on the ground. We hold these concepts entirely in our minds, yet believe they are "real" in the sense they represent how the world functions. Centers of gravity, lines of effort linking ends with ways and means, principles

Figure 1. Challenging our belief system



Source: courtesy of author, adapted by MCUP.

of war, and many other constructs are epistemological assumptions about war. Epistemological assumptions are about ideas, such as how we know we can go about engaging in war against adversaries, what acts of war are and are not, how one can evaluate forms of knowledge on war, how one might distinguish between "true" and "false" statements concerning warfare methods, and also what war manifests as.

In figure 1, a simplified arrangement of ontological and epistemological assumptions acts entirely within our minds so that the foundations of our social paradigm can develop. These ontologies and epistemologies are formed based on a shared belief system where we have subjective values, logics, and cultural and social functions that collectively define our identities and distinguish us from others in this world. Based on these philosophical and abstract foundations, we then produce theories and models that together allow us to employ methodologies to act on reality in a deliberate, coherent fashion. Theories form the logical frameworks that we use within a social paradigm that, when exercised, offer us outcomes and consequences that validate whether the theory is true or false, or in complex systems, accurate or inaccurate.[32] For example, in the Napoleonic era of European warfare, military theorists Antoine-Henri Jomini and Carl von Clausewitz presented different theories about war. Jomini posited that war obeyed external natural laws and that core principles of war, mirroring those found in the natural sciences, existed in every and each conflict; the cunning general able to configure strategies and tactics to exploit these war principles could win every battle.[33] Clausewitz combined the same Enlightenment natural science concepts as Jomini would, but also integrated German

Idealism and Romanticism, where war could not be reduced down with laws or principles, and this trinity of passion, chance, and reason would become the focus of any aspiring general to develop new ways of outwitting an opponent through decisive battle.

Theories link to models, where the model is created drawing from the same ontological and epistemological assumptions to relate how the data generated by applying a theory to reality is similar or familiar with respect to the model itself. For example, Clausewitz's model for explaining the critical hierarchical arrangement of military instruments of power was a gravitational metaphor drawing from Newtonian science. A "center of gravity" was the key thing, person, or construct that gave strength and the will to resist; destroying or defeating it would collapse the adversary and provide victory. Theories and models are interchangeable within a social paradigm, where for example physicist Niels Bohr presented his mathematical theory on atomic structure in 1913 using sophisticated formulas. For the layperson, he paired the theories with a model that explained all atomic matter as operating like the solar system; the nucleus representing the Sun and the electrons orbiting just like the planets. Physicists later would identify atomic elements in the universe that violated Bohr's 1913 theory, and they would replace his formulas with new, superior theory. But they kept his model, and often the operators of a social paradigm switch out various theories with new ones, and/or change models as they attempt to employ useful methodologies to think and act in complex reality.

The above figure has a recent "Space-Special Operations Forces (SOF)-Cyber" trinity model created as part of the military's exploration of how these three domains and forces assigned to the domains offer new developments concerning conflict.[34] Julian Jaynes, in explaining this relationship between theories and models, offers that "a model is neither true nor false . . . [but] only the theory of its similarity to what it represents."[35] One thing for readers to reflect on is how figure 1 places the ontological and epistemological assumptions (including what those positions ultimately reject as not part of reality) as the superstructures orchestrating all valued theories and models available to the military organization, including what could be brought into reality. When we call for innovative thinking, new ideas, or disruption to the institutional norms, those tend to also be strictly regulated by these overarching social processes.[36] We might take a blank slate, attempt to innovate on a difficult military topic, and generate something new, provided that the new concept is both useful to the organization and recognizable or susceptible to the same rationalization used for all related theories, models, and methods within that particular war paradigm. Anything outside or beyond those barriers face a far more difficult, if not impossible, journey to gaining acceptance and approval within the institution. This is how we often end up "pouring old wine in new bottles" as the biblical parable goes.

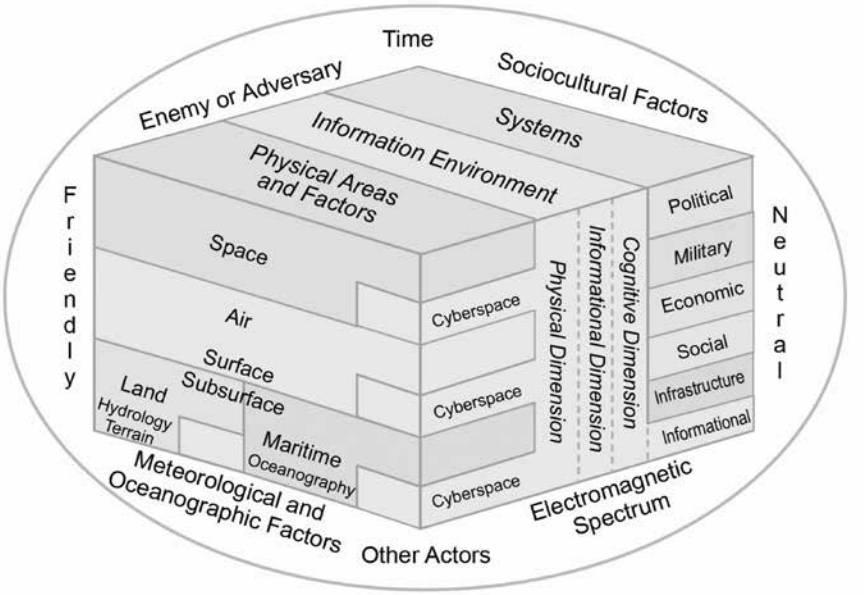
Of Triads, Linear Loops, and Three Ball Charts: A Newtonian Fetish for War

Modern militaries feature extensive training methods, educational programs, and a professionalized community of practice that seeks to equate military service with the same degree of specialization and unique knowledge curation such as the professions of law, medicine, or public policy. Militaries promote the notion that their decision-making methodology is founded on theory and models of sound, proven scientific reasoning, while they publish doctrine that describes how all military conceptualization, direction, and management of action should be conducted in uniform, universal, standardized, and predictable forms of exercise.[37] We declare ontologically that what we do in warfare is scientifically grounded, rationalized through clear reason and fact, and generally able to be tested and proven through some quantitative or qualitative treatment. War certainly can and does become chaotic, certain leaders with the "genius psyche" rise above others, and ultimately for Newtonian, Westphalian, Baconian warfighters of modernity, war remains a natural and enduring process exercised by nation-states in perpetual competition and cooperation.[38] Herbert Rosinski summarized this conception of warfighting:

> The classical doctrine of the balance of power as a dynamism of objective forces and necessities had *an exact parallel* in the theory of a natural balance of forces that was simultaneously developed in the field of natural science. Just as Newton succeeded in tracing the order and harmony of the celestial constellations back to the balance of the gravitational forces operating between the elements of the solar system, so the exponents of the balance of [social] power strove, *in the same spirit and with analogous concepts*, to grasp the nature of the conflicting forces and national interests in the political constellation of Europe in such a way as to achieve a balance between them and thus assure order and harmony in the European state system.[39]

In the U.S. military, one can quickly spot a pattern of Newtonian metaphoric devices in how the Services and commands conceptualize their concepts for warfare. Geometry, presented in this Newtonian style of conceptualizing warfare, dominates how the military profession attempts to understand and act in security affairs. This is how we ontologically understand social reality and the organization of state directed violence. Virtually all military doctrinal graphics demonstrate this Newtonian stylization through arrows, linear constructs, spheres, triangles, squares, cubes, or other configurations where "A plus B leads to C." This is described as *systematic* logic where reality is logically framed in isolation, with one part of the larger whole frozen in time and space so that it can be reduced, defined in a casual input leads to output dynamic, and then reassembled back into a whole. Geographic shapes retain a clear, readily understood form and function to illustrate the military concepts therein. The rigidity and order of these two-dimensional abstractions reflect the same certitude gen-

Figure 2. Holistic view of the operational environment

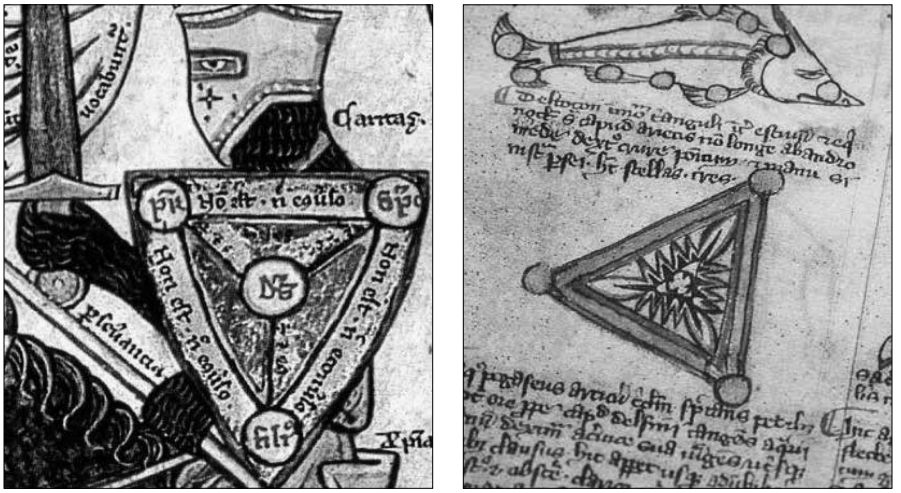


Source: *Joint Planning*, JP 5-0, 164.

erated at the ontological and epistemological level for our institutions. Clear epistemological assumptions on how one might visualize all of war in a clear geometric, ordered, stable relationship is illustrated below.

The graphic above comes from the U.S. military's *Joint Planning*, Joint Publication 5-0, and provides a telling example of how significant a grip Newtonian physics and similar natural science inspired constructs have upon modern armed forces.[40] These geometric metaphors have several origins, with recent centuries contributing scientific reasoning while earlier periods contributed ascientific and ideological implications instead. The modern, scientific ontology on war and what is best described as a positivistic epistemology (the world can be broken down, analyzed, reassembled, and universal laws applied to the whole) toward an enduring nature of war would emanate from the European Age of Enlightenment as it cast off earlier, prescientific and feudal-based beliefs on conflict. While the Middle Ages hosted a world governed not by humans, but a divine power and permanent societal norms and rules, the scientific paradigm shift toward a Newtonian world carried the construct of war along with it.[41] The Newtonian universe was deterministic, where "all events [were] the necessary results of a sequence of causes and reducible to the transmission of a single and invariant motive force. Such processes were also necessarily reversible: the original state of any system could be restored simply by applying the reverse of any dynamic changes it had gone through."[42] For conceptualizing war with enduring principles and structures, such positivistic theories needed to be universally applicable in some degree; the Newtonian war theories must

Figure 3. Medieval examples of triangles, triads, and geometric shapes



Source: British Library (left); and Berlin National Library text catalogued as "Codice di testi astronomico-astrologici, Francia (?)" (right).

exist within all past and future conflict, able to be teased out of any war given sufficient measurement, data, and time. Further, it could be simplified into formulas so that the entire military institution could readily grasp and apply it repetitively, otherwise it would be considered useless.

Yet, several centuries ago before this grand paradigmatic shift to Newtonian thinking, European militaries were quite unlike the modern versions of today, although many of the symbols, tools, and tactical constructs remain generally constant.[43] The Middle Ages militaries were organized differently, led by titled elites that were largely uneducated in any formal war education, staffed by trusted family members, friends, and business partners seeking profit.[44] They would conceptualize warfare not from any scientific rationalization, but from either divine positive law set down in scripture or determined through human reason and experience that would be reinforced by cultural or societal practices.[45] This often was due to largely agrarian based societies, the immense costs and time required to raise, train, move, and employ an army, as well as the significant risks if one was not exceedingly sure of a successful outcome in advance.[46] Rival nobility, despite competing fiercely through violence, trade, and marriages through constant preservation or expansion of their family wealth would agree to generally established rules for war that were often intertwined with religious edicts and regulation. Premodern military officers neither attended school for war nor were they required to study books or take examinations for advancement in rank or position.[47]

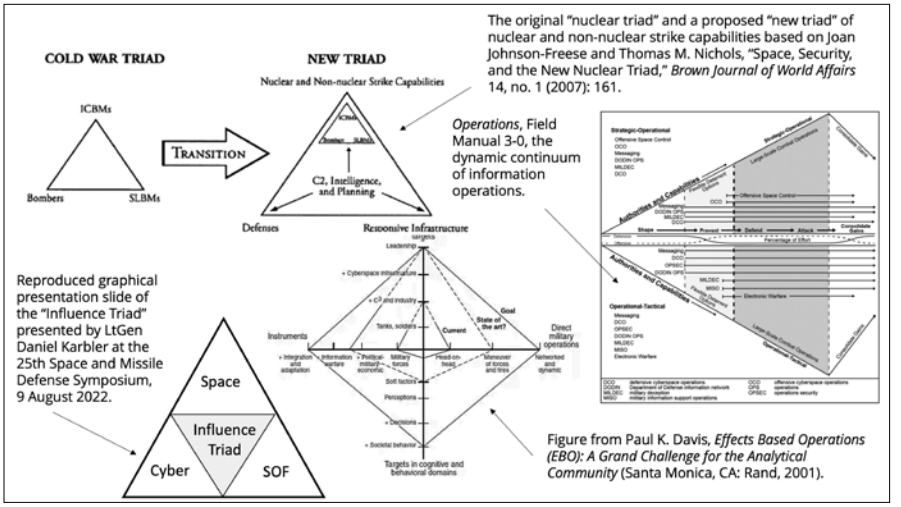
For feudal militaries prior to sixteenth and seventeenth century natural science developments, war and the conduct of armies and navies in warfare would be conceptualized through eclectic and often locally curated knowledge and training based on religious, cultural, and experience-based constructs. Triangles

and other geometric symbols in these times came not from the careful measurements of Vauban's fortification manuals, but from long-established metaphoric devices for reason such as from Saint Augustine. Chad C. Pecknold, in describing Augustine's development of a trinity concept for early Christian church doctrine in the fourth century ACE would occur in response to the regulative needs of an expanding bureaucracy seeking standardization. Pecknold, writing on how Augustine sought to standardize early Christian concepts including the Holy Trinity, would pursue clear rules and regulation to prevent misinterpretation and heretic deviations: "Trinitarian doctrine was moving towards formalization because it quite simply needed rules. These developments were primarily about how the church was going to think properly and worship God, and on that basis, it had a gatekeeping function."[48] This is *not* to suggest that mathematical rigor did not exist, as it stretches back to ancient Greek astronomy, mathematics, and the study of weights as well as early medicine.[49] But the high illiteracy, cost of education, and the difficulty to access both the knowledge and the printed information prior to innovations such as the printing press meant that prior to the Middle Ages, such knowledge was specialized, exclusive, and scarce.

Learned war knowledge abounded in the antiquities, but the collapse of the Roman Empire produced multiple long-term effects that would stymie any organized, formal education from continuing until the twelfth through fourteenth centuries of European renewal.[50] Common sense, experience, and the widespread gospel of dominant faiths provided much of the bulk of knowledge for how to exist in civilization, to include the "what, how, and why" of waging war. Additionally, premodern societies would blend various logics and offer a complex belief system where the analytical rigor of mathematics could manifest in highly accurate astronomy, yet the court astronomer would stand beside the court astrologist there to compliment the interpretation of when, how, and why the planets were moving. Royal elites might make significant political decisions including when and why to wage war based on both the accurate predictions of when Mars would be in a specific point in the sky, and the understanding that the god of war could assure them military victory if the people obeyed and offered proper offerings during key times or seasons. On the battlefield, even the best general could be defeated by an adversary, yet the rationalization of whether one is victorious or defeated largely rested in supernatural justifications. Rituals mattered as much as sound practices, and only the proper adherence to both in the prescientific world could lead to victory in battle.[51]

In the seventeenth century, Europe changed radically and quickly transformed the rest of the world, often to the detriment of those on the receiving end of these newfound powers and technology. In 1644, the French mathematician René Descartes (latinized name of Cartesius) inspired the modern scientific movement as well as a dramatic conceptual shift away from the Christian medieval period where "what is true, what is real" transformed from the external authority of a supreme deity to that of inquisitive, rational, and analytical

Figure 4. Trinities, triads, and pyramids

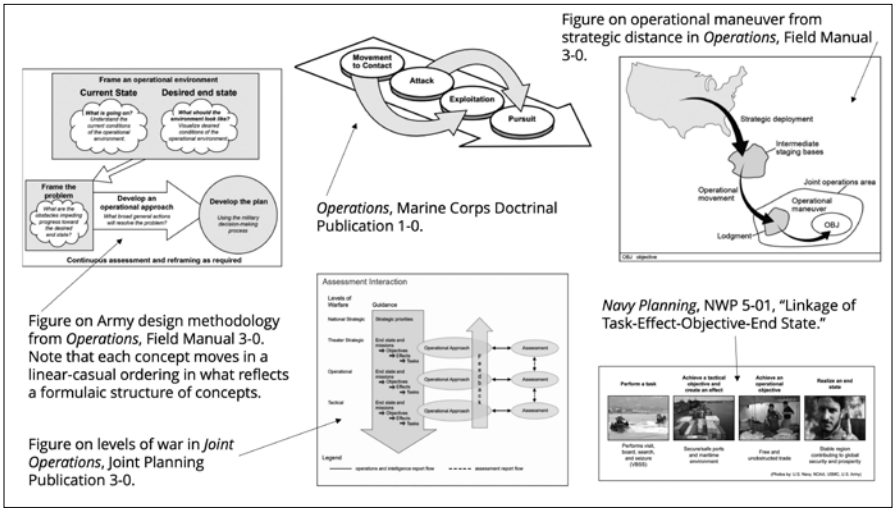


Source: courtesy of author based on elements from Paul Davis, *Effects-Based Operations: A Grand Challenge for the Analytical Community* (Santa Monica, CA: Rand, 2001); and Joan Freese and Thomas Nichols, "Space, Security, and the New Nuclear Triad," *Brown Journal of World Affairs* 14, no. 1 (Fall/Winter 2007).

oriented humans. Descartes' expansive work on (what would become known as Cartesian) geometry would use algebra as the foundation for forming a system of knowledge. This would in turn inspire further scientific research, including the inspiration to propel a young Isaac Newton to write his 1687 *Philosophiæ Naturalis Principia Mathematica* that contained his natural laws of motion as well as the law of universal gravitation. Newton's and Descartes' approach would be best understood within the context of natural sciences, where physics addresses aspects of reality in a scientific manner unlike all previous efforts of theologians, philosophers, and tinkerers. In the race to professionalize, militaries would seek to extend a Newtonian style to warfare and assimilate select terminology, metaphors, models, and methods to establish new form and function for understanding warfare.

Contemporary military doctrine forms the foundation for how militaries think and act in modern warfare. Doctrine is defined as "fundamental principles by which the military forces or elements thereof guide their actions in support of national objectives."[52] Chris Paparone, in highlighting how modern militaries mimic natural sciences to impose particularly mechanistic, engineering-oriented worldviews, questions how any military doctrinal *principles* are indeed *fundamental*? In modern military usage, there is a clear and intentional effort to resemble "the logic, grammar, and rhetoric of Sir Isaac Newton's *Principia Matematica,* advocating a view of the world through a machine-like precision of algebra."[53] U.S. military science, as expressed in doctrine, training, and decision-making methodologies, is structured around what James

Figure 5. Linear causal relationships (A plus B leads to C logic)



Source: *Joint Operations*, JP 3-0 (Washington, DC: Department of Defense, 2011); *Navy Planning*, NWP 5-01 (Norfolk, VA: Navy Warfare Development Command, 2021); *Operations*, ADP 3-0 (Washington, DC: Department of the Army) 2-3; and *Marine Corps Operations*, MCDP 1-0 (Washington, DC: Headquarters Marine Corps, 2011), 9-4.

Der Derian artfully termed the "Bacion-Cartesian-Newtonian-mechanistic" model.[54] Paparone goes on to argue that "this architecture-like superstructuration of military episteme has arguably become a constricted frame," where modern military science continuously invents and recycles terms, concepts, and models to mirror the natural sciences.[55] The geometric triangle modeling above is reinforced by the linear-causal arrows, sequential and systematic logic depicted below, as well as the next illustration with spheres, orbits, loops, and centralized hierarchical relationships. Again, the graphics are two-dimensional, but the meaning behind how they are composed remain Newtonian due to our ontological and epistemological assumptions on what war must be.

The way militaries attempt to illustrate the complex and dangerous phenomenon and constructs of modern warfare undertook a gradual transition from an earlier Napoleonic era understanding that would, historically speaking, show clear dependence upon natural science concepts from geology, physics, engineering, biology, and other available fields of successful scientific progress. We would recast war using natural science, where the enduring nature that made all chemistry able to be measured and validated universally would be extended into war. The certitude of gravitational fields and planetary bodies would be projected into how nation-states and their instruments of military power featured stable, ordered centers of gravity, and conflict would be explained using borrowed scientific concepts such as "spectrum of war" relying upon the spectrum of light.[56] J. F .C. Fuller, a twentieth century military writer and veteran of World War I, would use epistemological positivism as a foundational logical underpinning of what a scientific foundation for war *must include*.

Frustrated with the vast devastation and static trench warfare of World War I, he would argue in the interwar period: "[By] means of the inductive method we attain to science by collecting facts, by sorting these into categories, by extracting their values, and on these values erecting theories. By putting these theories to universal tests, by degrees we can extract laws which form our working principles, our weights and measures of war."[57] Fuller's reliance on Newtonian styled, positivist ideas would shape many aspects of how modern militaries in the twentieth century would understand war using scientific rationalism and natural science constructs.

War, over thousands of years, was unscientific and thus all existing theorization of war was, for Fuller, some similar manifestation of an alchemistic approach to warfare that might generate some useful effects and processes, but without a scientific transformation, fools were just attempting to turn lead into gold on battlefields without any analytical rigor or scientific reasoning. Fuller argued that a truly scientific way of rationalizing war would not just help use military artistry to deal creatively with events on present battlefields that remind us of past conflicts, but that a scientific methodology will permit us to deal with new and emergent circumstances on future battlefields never before experienced. His work in the early twentieth century would largely define most modern military doctrine, to include this extensive fixation with defining and explaining war in clear, natural science constructs. He clarifies this tension:

> Here, then, is the supreme difference: If we can establish a scientific method of examining war, then frequently shall we be able to predict events—future events—from past events, and so extract the nature and requirements of the next war possibly years before it is fought.[58]

Fuller sought a "machinery of rational thought," using those exact words, drawing from philosophers such as the French positivist Auguste Comte, the philosophy of Francis Bacon, and Descartes' positivistic process of separating everything into the simplest component parts and working upwards.[59] Newtonian ideals were sought, with Fuller oscillating between Newton and Charles Darwin, particularly social Darwinism, as primary sources of inspiration for how a scientific foundation for war ought to look like.[60] Fuller held to a deterministic ontology that reality required us to start all thinking based upon established facts and scientifically rigid methodologies, whether one was pursuing greater process improvement or attempting imaginative divergence from the existing order. "Imagination must be controlled by method and founded on fact. . . . Imagination works by hypothesis."[61] Thus, all effects are linked to some causal phenomenon, whether we realize it or not as it happens, and the world can be frozen in time, deconstructed, analyzed, reassembled, and the future of that system predicted with ever-increasing clarity if a scientific methodology is established and improved on. The ontology and epistemology that generates this Newtonian styled war paradigm continue to dominate, where modern doc-

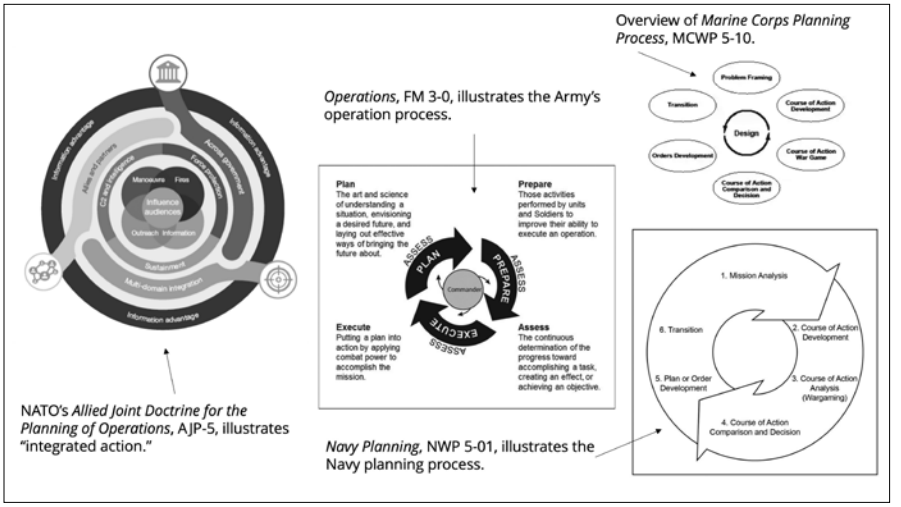
trine simply integrates new terms and concepts while simultaneously stripping them of anything that violates these overarching war beliefs.

Thus, despite the twentieth century ushering in entirely new war domains (space, cyber) intertwined with emerging fields of quantum, complexity, and systems theory, the military forces of the twenty-first century continue to extend the Newtonian style popularized in the seventeenth through nineteenth centuries into contemporary wars and beyond. "Centers of gravity" clearly hark from Newtonian origins, while "levels of war" appear to draw inspiration from geology (which would also influence psychology and other nonnatural science disciplines).[62] Warfare, regardless of maneuver on the fields of battle, are conceptualized within a linear, sequential, formulaic logic of A plus B leads to C formulation. Shimon Naveh, Jim Schneider, and Timothy Challans described this military assimilation of Newtonian or natural science metaphors to transform the understanding of warfare out of the Middle Ages and into the Modern Age:

> The Renaissance at last provided the strategist with the intellectual planning tools with which to bridge the gap between worldly perception and mental conception. This new conception as nothing less than the "geometrization" of military space and time. *It meant that a common military "chessboard" would define the conduct of military operations. . . .* The physics of Sir Isaac Newton would set the strategic chessboard in motion. Newtonian physics was a direct consequence of the three-dimensional worldview wrought by the Renaissance. Newton's three laws of mechanics provided military strategy with which to plan campaigns. The metaphor was the idea of mechanical force. Once having grasped the nature of mechanical force, it became only a matter of time before the practical aspects of the idea would surface. Napoleon, an artilleryman, with a solid background in mathematics and physics, was one of the first classical strategists to recognize that to use force effectively you had to *concentrate* it.[63]

The spheres, orbits, loops, and logical arrangement of concepts into centrally arranged hierarchical models is shown below in the next figure. These few selections dwarf the vast number of similar arrangements available throughout nearly every single military doctrine, regardless of service, domain, or area of specialization. Virtually everything in modern warfare can be articulated and illustrated using models, metaphoric devices, and terminology that not only can be universally understood by almost every single member of the armed forces today, but likely many previous generations of similar servicemembers going back centuries. Our Newtonian stylization could, if we had a working time machine, make sense to military professionals a century ago or further, if we could carry modern doctrine with us and show them.[64] Simplicity and universal convergence on foundational warfare knowledge is important and cannot be

Figure 6. Spheres, orbits, loops, and centralized hierarchies



Source: *Allied Joint Doctrine for the Planning of Operations*, AJP-5, (Brussels, Belgium: NATO Standardization Office, 2019), 2-6; *Operations*, FM 3-0 (Washington, DC: Department of the Army, 2017) 2-25; *Navy Planning*, NWP 5-01 (Washington, DC: Department of the Army, 2013), 1-4; and *Marine Corps Planning Process*, MCW 5-10 (Washington, DC: Headquarters Marine Corps, 2020), 2.

understated, yet change advocates across the military today raise fair objections that contemporary warfare is *outpacing* the depth, sophistication, and value of the doctrine and models being provided. If entirely new domains such as cyberspace, space, and the nuanced "gray zone" areas where special operations can create peculiar and exquisite effects lend increasing complexity (if not chaos) to the already robustly complex traditional physical domains that defined both World Wars, then how might it be possible for earlier Newtonian styled war concepts to accurately explain emergent, increasingly complex (or chaotic) war contexts?

This emphasis on conceptualizing warfare models in a Newtonian styling extends beyond military doctrine, arguably into broader war philosophical framings such as what retired Army Green Beret Grant M. Martin sees as a bifurcation of all security affairs into a "peace" or "war" bucket.[65] The multiple examples presented may work in specific contexts provided the situation is stable enough for a military force to apply the geometric construct and manage their decisions and activities with engineering-like precision. Yet these models are rigid, adhering to the natural laws defined in natural sciences such as gravity or motion. Categorization into war or peace becomes like a light switch or a coin flip. However, in complexity theory, systems theory, quantum theory, and some postmodern disciplines there is a disruption or blurring of these clear and stable constructs. The Newtonian war models reliant upon particular and simplistic geometric devices should give way to alternatives that, while mathematical, force a profession to think differently about warfare.

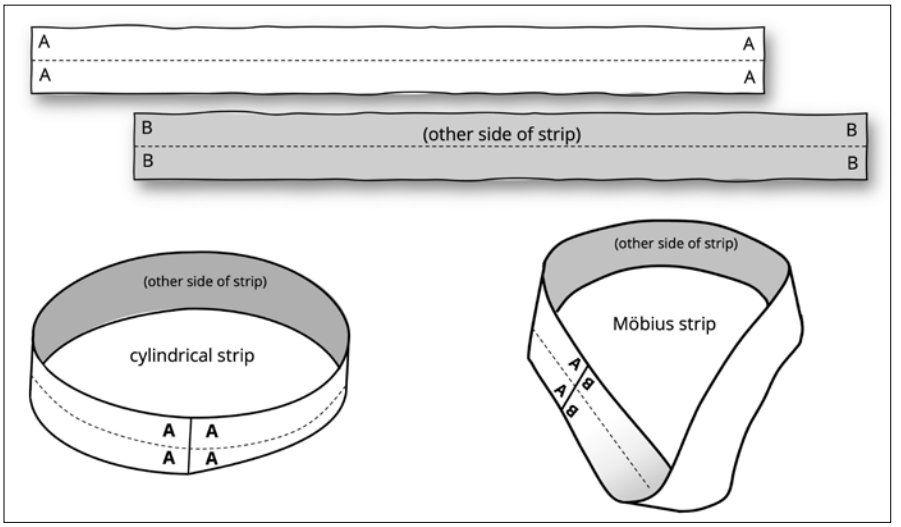
From Orientable Geometric Shapes to the Möbius Strip: Complex Warfare Reframed?

This section introduces some decidedly non-Newtonian constructs that still must be depicted on two-dimensional renderings, including this article on a computer screen or printed on paper. This tension is one of recognizing the ontological and epistemological dependencies our modern military paradigm is wedded to, and that of arguing over models and methods that already subscribe to such beliefs. To offer an example spanning thousands of years, the earliest depictions of "infinity" featured shapes or creatures such as the ouroboros—a serpent or dragon eating its own tail—which presented the idea of an infinite loop for premodern societies. In modernity where the fields of mathematics have invested significant research into how infinite properties can be used through sophisticated formulas, the idea of "infinity" is rendered in a similar symbol, but manifests through quite different ontological and epistemological structures. Or if we return to the celestial and societal arguments on whether Earth exists in a geocentric or heliocentric universe, the drawings for both included planets and stars moving in various orbits, but the ontological and epistemological differences between the two could not be greater. In this section, new constructs will be presented that break with the past military fixation on a Newtonian styled war paradigm, yet they too need to be presented in the same two-dimensional space. They require different ontological and epistemological assumptions on war, and thus represent a paradigm shift in how our forces might think differently in complex reality. The fundamental issue becomes: Is this even possible?

How might military forces shift from oversimplified conceptual models of warfare to ones that might more readily take the weight of full multidomain, complex, and emergent security challenges in today's hyper technological, fluid, and networked reality? Often, a useful form of immersion is to present something tangible that carries with it some intangible, abstract qualities. Consider a simple challenge involving a narrow strip of paper in the shape of a long rectangle with a centerline drawn down the long axis. The challenge is to give this strip of paper to a military audience and ask them how one might turn that into something that can double the length without any rips, tears, or destruction of the strip of paper (drawn on *both* sides of the rectangle strip). Many might turn the strip into a simple loop, as illustrated below. Yet the centerline and each newly formed outer circular edges remain the same length, thus failing this exercise. Clearly, there must be some trick here to accomplish this task. The trick is shifting from a particular dimensional logic to one that extends beyond the simplistic.

For those willing to put one twist into the rectangle before connecting the opposing ends, they will notice that the centerline still lines up, forming a continuous unbroken centerline that remains the same length as the original rectangle. Asking the audience to then start at any point on the outer edge and trace along this curious shape, they will soon discover that at one lap around the

Figure 7. The paper strip challenge



Source: courtesy of author, adapted by MCUP.

twisted loop, they arrive at the opposite side they started on! They must complete two full laps to return to the starting point, indicating that this curious object does "double the length" of the original object. There are more unusual properties to this object, which is defined in mathematics and the specific field of topology as the Möbius strip. This isn't a new concept, but it remains something divorced from modern military doctrine, models, and theories. Additionally, the institutional defenders of the Newtonian style might object that such things overcomplicate what ought to remain as simple as possible for the maximum audience. This is not only a total misunderstanding of complexity (to include how war is inherently the most dynamic and complex thing humans are capable of doing), but an excellent example of paradigm incommensurability. For those willing to violate the dominant war paradigm, figure 7 provides the first key.

A Möbius strip is a *nonorientable* surface, meaning that unlike orientable surfaces such as a sphere, rectangle, or triangle, the Möbius lacks any clockwise or counterclockwise properties. If a traveler within a Möbius strip moves through the form and follows the loops, they return to the starting point but are now transformed into a mirror image of the original, reflecting earlier societal depictions of infinity. Continuing further with another loop and the transformation flips once more, occurring infinitely and without any ability to orient to directions such as navigating on a sphere (such as our planet). All nonorientable surfaces, when visualized in three dimensions, only have one side. Essentially, if one is within a nonorientable surface such as a Möbius strip, attempts to move clockwise or counterclockwise beyond a single isolated "trip" are impossible to impose some order of consistency to orientation. The trip inverts into a mirror image at the end of the journey, which is also the starting point para-

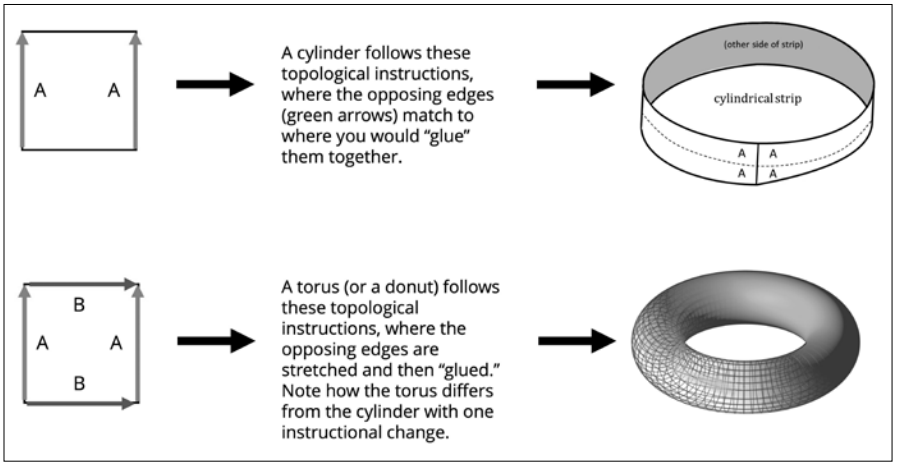
doxically. Nonorientable surfaces are still Cartesian, yet the metaphoric value of these concepts differs from the dominant Newtonian styled models that are simple, orientable, and less dynamic. Fans of classic video games can quickly distinguish the flat, two-dimensional scrolling environments of *Super Mario Brothers*, *Double Dragon*, and games like *Spy Hunter* with those of modern three-dimensional games as one useful way to understand topology; players can only move left-right, or up-down that correspond to an *orientable* two-dimensional game surface.

In a two-dimensional world like *Centipede* or *Donkey Kong*, the player's icon as well as all other things in the game can only interact in this same flattened, two-dimensional world. Yet, in games like *Pac-Man*, the player can move "magically" from one edge of the screen to the opposite one instantly by using one of the tunnels that link to the other side. A Möbius strip features this sort of nonorientable phenomena that will be expanded below. This seems confusing because most of the world (outside of some mathematicians, physicists, and philosophers interested in topology) conceptualize reality in the traditional Newtonian styled worldview. Modern military doctrine explains entirely in two-dimensional *Donkey Kong* styled illustrations and graphics on every aspect of warfare conceptualization. While the often-overlooked topological abnormalities of those magical *Pac-Man* connected tunnels to opposing sides of the map offer a useful steppingstone out of the strictly two-dimensional, Newtonian-styled conceptualization to different, novel ways to reimagine complex security affairs.[66]

Topology requires a little more explanation on how "surface" is significant, so that militaries can begin to think about the metaphoric preferences in current doctrine and modeling (the space-cyber-SOF triad, centers of gravity, integrated deterrence, or the gray zone) and how they all adhere to what is still a Newtonian styled framing of warfare. A surface is a space where every isolatable point has a "neighborhood" that appears to be a two-dimensional disc. If you take an orange or pumpkin and slice it right in half at the equator or anywhere else, you still will end up with a flat disc shape. Some surfaces have boundaries, while others in topology do not. The Earth is a sphere object and does not have any edge where an explorer might fall off, thus it is topologically a single surface stretched into a topological sphere.

Topological objects that pair nicely with traditional military models and constructs do not involve much stretching at all, as they follow quite simple rules and are devoid of any of the curious properties of something like a Möbius strip. The triangle has a long and storied history in military affairs, from adorning shields of Medieval knights to the strategic framing of the circuitous trading of slaves, sugar, and rum between West Africa, the West Indies, and the seventeenth/eighteenth century northern colonies of British North America, to the nuclear triad underpinning American strategic deterrence throughout the second half of the twentieth century into present day. From the most minute technical and tactical to the grand strategic, military forces and their political

Figure 8. Basics of topology and familiar shapes (the Cartesian-inspired military frame for war)



Source: courtesy of author, adapted by MCUP.

leaders conceptualize through models that are depicted in these clear, flat, and static geometric forms.

Taking the rectangle challenge once more, the rectangle can be made into a cylinder by connecting two sides together as shown below. The top and bottom of the cylinder are boundaries that would act as edges that an explorer could fall off, if they were on the cylinder topography moving about. Topologists use mathematical formulas to draw surfaces because beyond the simplistic, well-recognized shapes of triangles, cubes, and rectangles, many objects that bend or even break dimensional properties are hard or impossible to draw. Readers might consider that in military doctrine, every single conceptual model depicted is drawn in a flat, two-dimensional plane, meaning that anything in three, four, or more dimensions must be simplified (or at times, oversimplified) to be depicted. The admitted vast complexity of modern warfare is unavoidably reduced toward conceptualization in a *Mario Brothers* flattened world. Figures 4–7 present this as how we attempt to visualize the complexity of modern war. It is not just the convenience of two-dimensional rendering of symbols and artwork, but the Newtonian stylization of our entire war paradigm that requires such an ontological and epistemological framework for war to be broken down, analyzed, reassembled, and subjected to other pseudo-scientific processes.

The figure below helps demonstrate this by showing the mathematical framing on the left and how those shapes would be drawn in illustrations on the right. The cylinder shape is quite easy to conceptualize and draw into two-dimensional space, despite it being a three-dimensional object. The torus or donut shape in topography is also depicted below and features a slightly more complicated mathematical framing. A torus starts like a cylinder with the edges of two sides corresponding to one another glued together, yet the other two edges also must be stretched and glued together. Picturing this in the reader's

mind, the sphere must be warped so that the two long, circular edges at the top and bottom of the cylinder are glued together, forming a donut or what might seem like the inner tube to a bicycle tire. The mathematical formulas and topographical instructions from this point become increasingly difficult to visualize, and eventually they cannot be drawn in two dimensions or even third dimensional spaces without sacrificing some essential properties.

Why might this be useful to modern military forces? When considering the thousands of years of military theories, methodologies, organizational forms, techniques, terminology, and shared belief systems of different military groups, there are some significant patterns across cultures, societies, and geographies concerning conceptual models that are either ascientific in origin (Augustine's Holy Trinity as a triangle) or inspired more recently by natural science constructs. For instance, almost every military task organization chart mirrors the ancient Greek treatment of how cities, families, and organizations are arranged in centralized hierarchies, like tree branches stemming from a larger trunk. The tree-form conceptual model "for nearly two millennia . . . has been an Aristotelian hierarchical model of concepts divided into mutually exclusive categories."[67] Greek and Roman prescientific rationalization of war would have the strongest influence upon later Medieval and early (European) modern militaries, yet across the ancient world military theorists would conceptualize and introduce natural world causality, universality, and patterns of historical precedent in order to deduce rules or principles that govern warfare. Sun Tzu's writings from more than 2,300 years ago in China demonstrate this with universal war tenets drawn from natural phenomenon:

> The onset of troops is like the rush of a torrent which will even roll stones along in its course. . . . The quality of decision is like the well-timed swoop of a falcon which enables it to strike and destroy its victim. . . . Energy may be likened to the bending of a crossbow; decision, to the releasing of a trigger. . . . Hiding order beneath the cloak of disorder is simply a question of subdivision.[68]

The ancient world would correlate inputs with outputs systematically, drawing from the apparent natural order of the world, while religions would institute divine laws and rules to explain the governing of societies. The gods might be fickle and difficult to predict, but elites that could interpret their actions or articulate their rules for humanity would frequently be an integral part of how and why militaries would go to war. Yet, even priests or oracles had to show some proof and translate so that fellow humans could comprehend the supposed order and rationale. Conceptual models from antiquity, whether ideological or philosophical in origin, suggest common mathematical, geometric, and natural world inspired arrangements used to represent abstractions such as war theory. Later still, the Renaissance would introduce scientific reasoning and usher in natural laws that offered testable proof of a hidden order of the world. Militaries have perpetually attempted to link these laws and rules,

regardless of origin, to the application of warfare, with a dramatic shift in European militaries toward a military science coinciding with the rise of natural sciences as well as a rebirth of earlier Roman state-centric drill, organization, and discipline.[69] The declaration of a war rule within this Newtonian styled war science provides a desired certainty, stability, or predictability in what has always been the most chaotic, unpredictable, and dangerous of human endeavors. When one can arrange cause and effect in clear, even predictive arrangements, it should not matter if the inspiration comes from divine decree or a mathematical formula explaining planetary motion if reliable results can be accomplished on the battlefield. Antoine Bousquet frames this scientific way of warfare:

> The successes of modern science in uncovering seemingly external laws of nature and developing or perfecting technological contraptions to take advantage of them has unsurprisingly proved highly attractive to military thinkers and practitioners seeking to dominate the battlefield and render their activity as predictable as possible.[70]

Contemporary military strategies extend from a clear, linear-causal rationalization of ends-ways-means that are regularly depicted formulaically in lines of effort, plunging forward in time toward predesigned objectives and goals frozen in an imagined future state.[71] Newtonian laws of physics aid most everyone in regular daily activities such as throwing a ball or driving a car. The question to ask military theorists and educators is whether all military doctrine and the theories, methods, and techniques of military doctrine should be so utterly dependent upon simplistic two-dimensional rendered Cartesian and Newtonian constructs *alone*? Might the emerging complexities of cyberspace, space, and special operations—peculiar activities in competition, in which deterrence and different types of warfare require conceptualization *beyond* this ever-dominant Newtonian style for conceptualizing modern warfare?

A Möbius strip is the first useful example of a model that disrupts the cognitive limits of the Newtonian style, and thus might become a useful metaphoric device for various complex military topics. Möbius strips have already been widely used in many fields and disciplines beyond mathematics, working as a conceptual model or metaphoric device for understanding complex business relationships, in literature studies, political science and psychoanalysis, archeology and history, postmodern philosophy, and even gender studies.[72] Many of these applications are metaphoric, where the qualities of the Möbius strip are reapplied toward nonmathematical, nongeometric contexts so that practitioners of entirely different disciplines might gain new perspectives and inspiration. Military forces could do as these diverse communities and disciplines have, yet this would require a significant disruption of the pervasive Newtonian styling depicted across all modern military doctrine.

The Möbius strip could be an exceptional concept to apply toward military challenges through modeling, metaphoric device, or even methodological construction. It features the ability to move in a path that traces all boundary

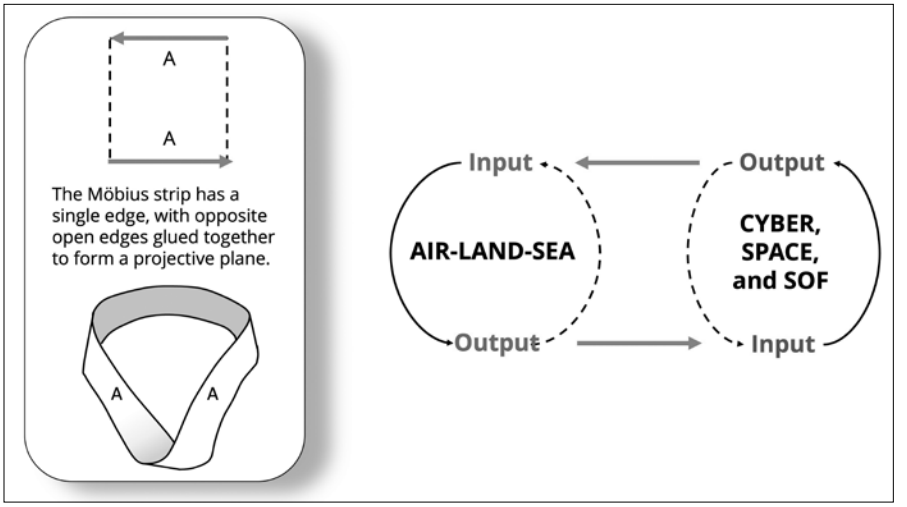
points in a single continuous curve, linking start point to end point and able to infinitely continue in this sequence perpetually cycling between mirror flipped forms. Due to the Möbius strip's unique properties, it also is an example of a chiral object that is distinguishable from its mirror image. The word *chirality* derives from the Greek word for "hand," and if someone attempts to shake the right hand of another person with their left hand, they will directly experience how hands are chiral objects. This is another departure from the Newtonian styling of military models and concepts that all remain uniform, reversible, and proportionally equivalent such as in the earlier figures of spheres, cycles, lines, and triangles. Although the strip is printed in two dimensions, it must be comprehended so that a third dimension is integrated due to these unusual properties that cannot be accomplished with traditional loops, spheres, cubes, or pyramids.

Möbius strips abound, metaphorically, in modern society. The popular science fiction movie *The Matrix*, which draws from postmodern origins, provides a wonderful example of Möbius phenomena where the main characters that exist outside the simulated Matrix digital world can hack into the system, entering the false digital reality where those that are conceptually "trapped" engage in their lives. The heroes are physically at risk inside the simulation as computer agents attempt to kill them inside, while other enemies and risks threaten their physical bodies as they lay vulnerable outside in the actual dystopian landscape that is reality. The conceptual struggles of Neo, the main protagonist, provide a telling example of a Möbius strip journey throughout the first movie as he questions which world is real and who he is or is not. Again, the strip is presented in two-dimensional space just as the static geometric constructs of figures 4–6, but we require a cognitive leap from our Newtonian style of thinking about modern war to one that breaks existing doctrinal and theoretical barriers.

How might Möbius strips replace the more rigid, simplistic Newtonian stylings for complex military affairs?[73] Once a Möbius strip is formed, one can cut along the entire centerline and instead of producing two new and smaller Möbius strips as one would get with cutting a rectangle in half (longways), the result is one longer strip with two half-twists. Mathematically, in orientable planes such as a map of the United States or a square illustrated below, the four color theorem proves that no more than four colors are required to color the regions of any map so that no two adjacent regions share the same color. Yet, the Möbius strip violates this due to its unique properties.[74] It breaks a host of rules that Newtonian inspired constructs must follow, making these nonorientable objects worthy of consideration for complex military contexts. Why limit oneself to conceptualization of a rigid Newtonian stylization when so many other options and ways to break out of those conceptual barriers exist? Complex warfare ought not be conceptualized within such explicit, quantitative, and systematic representations.

In figure 9, the topological instructions for creating a Möbius strip are adapted into a conceptual model for how military organizations, as the directed

Figure 9. Graphic representation of a Möbius strip through a metaphoric device



Source: courtesy of author, adapted by MCUP.

extension of their national political, social, and cultural desires, engage in a wide range of security activities to complete, cooperate, deter, and engage in organized violence perpetually, iteratively, and in an emergent, nonlinear fashion. Complexity theory requires careful consideration of nonlinearity, systemic relationships (nonreduceable), and how emergence largely prevents such dynamics from being depicted in Newtonian stylized approaches.[75] Even below and in subsequent illustrations, forcing a Möbius strip into two-dimensional space carries the risk that some readers might misinterpret the concept, oversimplifying it into a cylindrical shape where an OODA loop, campaign planning formulaic, ends-ways-means linear-causal relationship could be inferred.[76] Militaries need to shift away from *Donkey Kong* static and flat concepts to topological alternatives, even though printed mediums still insist upon a two-dimensional rendered construct. The *meaning* of those constructs and the theoretical underpinnings is how one can pivot from one conceptual frame to another less explored. Figure 9 again renders the construct in two dimensions, yet readers able to conceptualize the ontologically and epistemologically different rendering of the Möbius strip in their heads can follow along to the simplified graphic and consider the space-SOF-cyber dynamic differently than with a triangle, interlocking geometric shapes, or a Venn diagram.

Figure 9 acts as a bridging device to introduce non-orientable topological objects as potential metaphoric devices and new conceptual models for militaries desiring to break out of this "Newtonian fetish," as this article's title intentionally provokes readers with. In order to prevent strategists and planners from assimilating nonorientable, peculiar topological concepts back into a linear, *systematic* (reductionist, A plus B leads to C in preconfigured input/output relationships) mindset, additional explanation and illustration is required. The

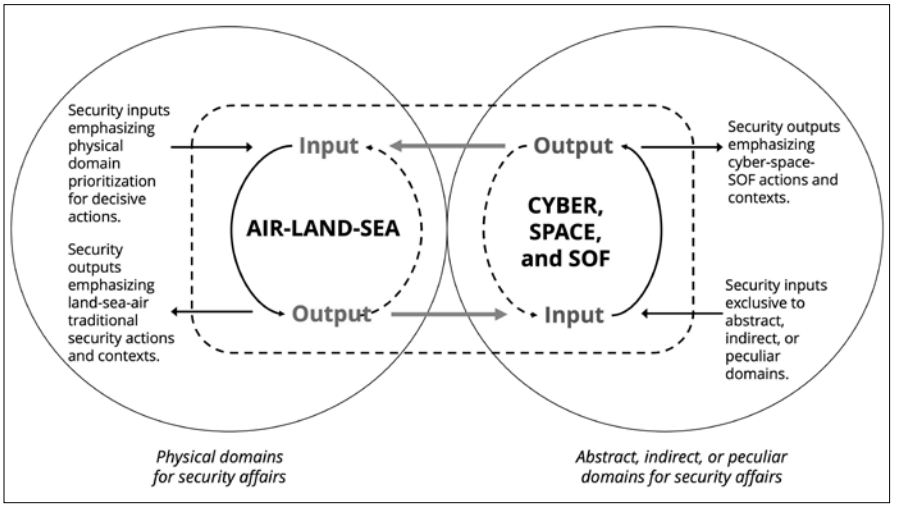
Möbius strip expands in the next figure below, gaining additional graphical depictions that attempt to pull viewers further into topological constructs that reject any oversimplification of complex warfare through exclusively Newtonian geometric rationalizations. This is where we continue to conceptualize in a decidedly non-Newtonian style, working with these two-dimensional graphics but thinking about complex warfare in ways that better match with complexity science, quantum, and how the space and cyber domains cannot be appreciated exclusively using terrestrial (air, land, sea) constructs and theories.[77]

The boundary of the Möbius strip in topological terms is equal to a circle, despite the strange shape and twisting. As the Möbius edge is unknotted, the entire strip can be stretched without crossing itself. Mathematically, the simplest knot possible is what is called the unknot or trivial knot, which is a topological circle. This is represented above both on the left where the dotted lines are in the topological instructions to create the Möbius strip and is further illustrated in the two separate frames below of air-land-sea and that of cyber, space, and SOF. Traveling through a Möbius object, one cannot leap off an edge, as they carry right over to the other despite being drawn in the topographical instruction to look like opposing ends of a square. Returning once more to *Pac-Man*, one traverses immediately from one side of the screen into the other side, despite moving away from the game board. This is how nonorientable topology offers new, arguably complex ways to explore, define, and explain complex warfare *beyond* Newtonian limits. How the Möbius strip forms a single topological surface yet exercises movement of the traveler on both sides provides the framing device to consider the physical domains (air, land, and sea) for security affairs and how conflict, competition, and deterrence exercise in abstract, indirect, or peculiar domains for security affairs.

Below, different inputs and outputs enter consideration depending on what part of the Möbius strip is being traveled, as well as how the traveler has experienced previous passages where a collection of different inputs and outputs have acted *systemically* (holistically, nonreducible, framed with increasing abstraction toward larger and larger system relationships). What is interesting about figure 10 rendered unavoidably in two dimensions is that one can opt to travel in a variety of paths just as any journey in an actual Möbius object would feel like. Applied to modern complex warfare and dynamic security affairs, one could cycle through iterations of just one or either side, or mix activities traveling the entire pathway in myriad, nonlinear cycles. This may approximate modern complex security affairs in that some phases of international competition, cooperation, deterrence, and acts of organized violence across state, nonstate, commercial, group, and decentralized movements may exercise exclusively in just part of the Möbius below. A conflict featuring covert or clandestine special operations with significant cyberspace and space operations may avoid any traditional patterns (physical domains, declarations, and clear acts of war) and in some situations might transpire without any external awareness of the societies being acted on.

In the configuration above, the Möbius strip is depicted in one of many

Figure 10. Expressing multidomain competition, deterrence, and warfare as a Möbius strip



Source: courtesy of author, adapted by MCUP.

possible alignments.[78] Arguably, there is not going to be a best configuration, as the nature of complex warfare prevents any sort of objectivity, stability, or predictability therein. Instead, readers might consider the topological opportunities for reconceptualizing the suggested Möbius strip above with something else. The above Möbius strip addresses core tensions between the well-established, historically recognizable arena for Westphalian nation-state warfare and politics that has exercised through air, land, and sea for centuries, spanning peaceful and cooperative/competitive contexts to that of total war efforts of annihilation.

The other side of the Möbius strip above addresses the emerging, rather abstract, and peculiar domains of cyberspace, space, and how modern special operations forces are able to operate in exquisite, unique, indirect and alternative ways both in times of apparent peace and that of active, recognized warfare. For instance, special operations forces work in unconventional warfare (UW) applications that may span years or decades of slow, nonlinear, often invisible, or incredibly gradual efforts that are emergent and hardly the sort of operations that make the front pages of the news. Indeed, perhaps the best UW operations are never discussed due to the nature of their obfuscated, invisible transformation succeeding. Yet, a highly successful UW campaign might lead to significant long-term security goals, and even accomplish them in a way that is nonattributable or obfuscated from societies realizing who did what to whom when and why. The shadowy, complex, and tangled worlds of cyberspace as well as the unique aspects of an emerging space domain for security affairs are even more difficult to comprehend, much less articulate clearly in crisp, two-dimensional graphics and models for militaries and policy makers to feel certain of.

The Möbius strip is but one of many interesting and non-Newtonian forms

for reconceptualizing complex warfare anew. Indeed, skeptics of the above graphics might argue that the Möbius strip, as rendered in two dimensions, is too like the Newtonian styled triangles, cubes, arrows, and other simple geometric models used today to conceptualize all aspects of warfare. Yet the Möbius strip might be considered a gateway drug to strategists and planners in order to explore a whole new world of increasingly sophisticated ways to truly introduce complexity theory, systems theory, and postmodernism into the security affairs debate on why the current system is failing. Another fascinating topological object, the Klein bottle, is an object without any inside or outside, yet as a single non-orientable surface, is able to pour into itself.

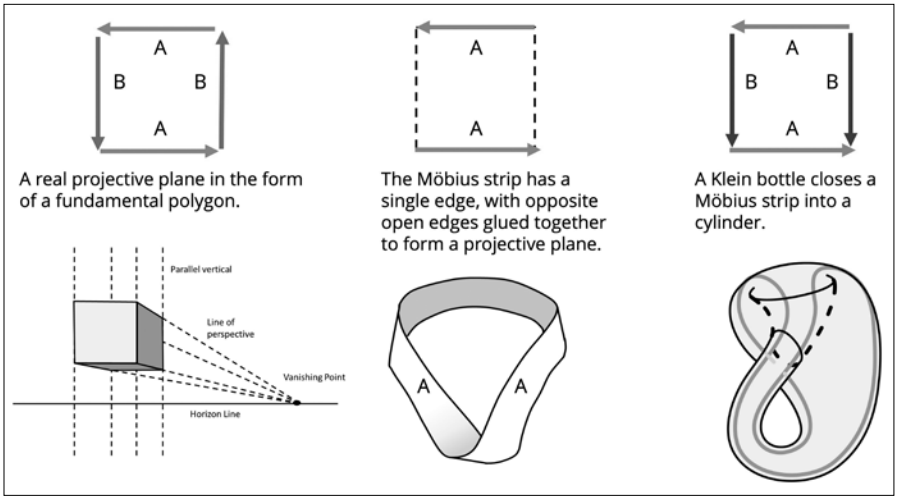
Moving from Möbius Strips to Klein Bottles: Further Newtonian Dismantlement?

The Möbius strip had as one of its unique properties an unknotted edge where the boundary is equal to a circle, stretching without crossing itself. However, if two Möbius strips are glued together edge-to-edge, a Klein bottle is formed that possesses a one-sided surface with no boundary that cannot be embedded in three-dimensional space. A Klein bottle is tricky to conceptualize, and while they can be created in three-dimensional space including boutique wine decanters for mathematically minded wine lovers, topological mathematician Maia Averett offers a convenient summary:

> The only way to imagine [a Klein bottle] is to imagine pulling one end of the cylinder through the surface of the cylinder and matching up with our circle from the inside. The resulting representation of the surface doesn't look like a surface, but it really is. Its funny appearance is just a consequence of the way we had to realize it in our three-dimensional world.[79]

Mathematically, Klein bottles are a paradox when rendered in three-dimensional space, as they are not really contained in space as they are paradoxically containing themselves; a topologically imperfect model created in three-dimensional space has a hole produced "so that its construction already introduces singularities which then through the in-formation flow produces the whole structure, so that the whole structure is produced from a hole, and this returns to the singularity to complete the flow."[80] Many readers no doubt are scratching their head at this, and for applications to complex warfare, this is where a distinction must be made between analogies and metaphors. Complex warfare is not analogous to how a Klein bottle exists mathematically, just as that same complex warfare is not actually the integrated cube first shown in figure 2 as depicted in *Joint Planning*, Joint Publication 5-0. Metaphorically, there are patterns and behaviors within complex warfare and security affairs that can be conceptualized using either an integrated cube or with the Klein bottle, and it is up to the organization seeking greater understanding to determine which metaphor might be more useful.

Figure 11. Moving military metaphors beyond basic geometry



Source: courtesy of author, adapted by MCUP.

In the above figure, topology works with what are called real projective planes that are nonorientable two-dimensional manifolds, so that mathematicians can generate relationships and instructions to build a host of topological objects, many of which simply cannot be illustrated in two- or even three-dimensional spaces without certain compromises of the illustration (but not the mathematical formulation). These concepts are centuries old, and one can find the societal transformation in thinking about reality to one of topological consideration when viewing paintings from Renaissance artists in a museum. While Medieval and older paintings seem flat and strangely wrong in composition of perspective, Renaissance artists were among the first to compose artwork using real projective planes to create in two-dimensional artwork the illusion of three-dimensional space and objects. Hence, the painters broke out of older, less useful ways to conceptualize on how to create more realistic works of art, and by playing with topological concepts, they could develop entirely new ways to create two-dimensional art. For military professionals considering the Möbius strip, it is the simplest nonorientable three-dimensional object that can be depicted in two-dimensional space without losing much of its unique qualities. The Klein bottle should be considered the next level of conceptualization using this technique, except the Klein bottle can somewhat be depicted in three-dimensional space while still maintaining most of the unique nonorientable qualities that make it quite unlike a regular glass pitcher.[81] An immediate security example of Klein bottle-like behavior is found in the U.S. State Department's "Moscow Mechanism Report" press statement released on 22 September 2022:

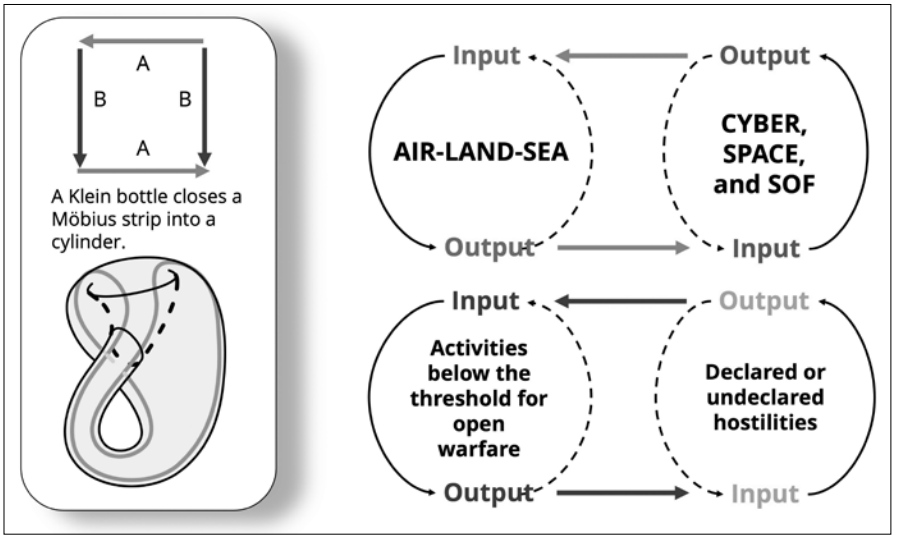
> The United States and 37 other countries invoked the Organization for Security and Cooperation in Europe's (OSCE) Moscow Mechanism on July 28 to examine the Russia's adherence to its OSCE Human Di-

> mension commitments on human rights and fundamental freedoms. . . . Specifically, this report documents that the Kremlin has centralized all federal and regional law enforcement authorities under Kremlin control; used so-called "foreign agent" laws to impose draconian penalties and fines on individuals and civil society organizations with any foreign contacts; effectively silenced freedom of expression, including independent media and criticism of the government through harsh censorship laws; and "created a climate of fear and intimidation . . . that is not in line with OSCE standards based on a pluralism and a strong and independent civil society." The report also makes clear that Russia's "(r)epression on the inside and war on the outside are connected to each other as if in a communicating tube."[82]

Again, metaphoric devices are what individuals, groups, and societies employ underneath all language so that terminology reflects into a rationalization of accepted theories, beliefs, and conceptual models that contribute to the formation of decision-making methodologies used to engage in complex reality.[83] This constitutes the social paradigm, and critical examination of the metaphoric devices as well as the conceptual models used can help any organization or person think differently when a paradigm is failing them in reality. We are working with our ontological and epistemological assumptions on war, but we are always as humans depicting these concepts in some two-dimensional graphic for sharing our ideas. How these graphics differ at the ontological and epistemological level are what matters. In figure 12, the Klein bottle construct is demonstrated on the left with the topological instructions as well as an approximation in two-dimensional space of what a Klein bottle looks like. On the right, the original Möbius strip configuration of the earlier figures is doubled, just as a Klein bottle can be produced by gluing two Möbius strips together in topological space.

Metaphorically (again, not mathematically analogous), militaries could combine two Möbius strip adaptations to further deepen a myriad of possible configurations on complex warfare. The many paradoxes of complex warfare such as how progress in eliminating terror group leadership would, often unavoidably, generate surges in societal resistance against "occupiers" and "infidels" in Iraq, Syria, and Afghanistan. In another Klein bottle example from Afghanistan, a military unit sought to improve a mountain village by digging a well close to town so that the local women did not need to walk an hour a day to collect water. The unit celebrated their humanitarian project, but soon found the well destroyed and suspected that enemy Taliban were responsible. Later, that unit learned that the women of that town sabotaged the well because those long walks were their only reprieve to socialize and get out of the house.[84] Military units search for schools to build, wells to dig, and enemies to kill, without often realizing that their own efforts "pour back into itself" and create some of the very problems they are seeking to solve. The popular military

Figure 12. Further along the Möbius: using a Klein bottle for doubling the Möbius



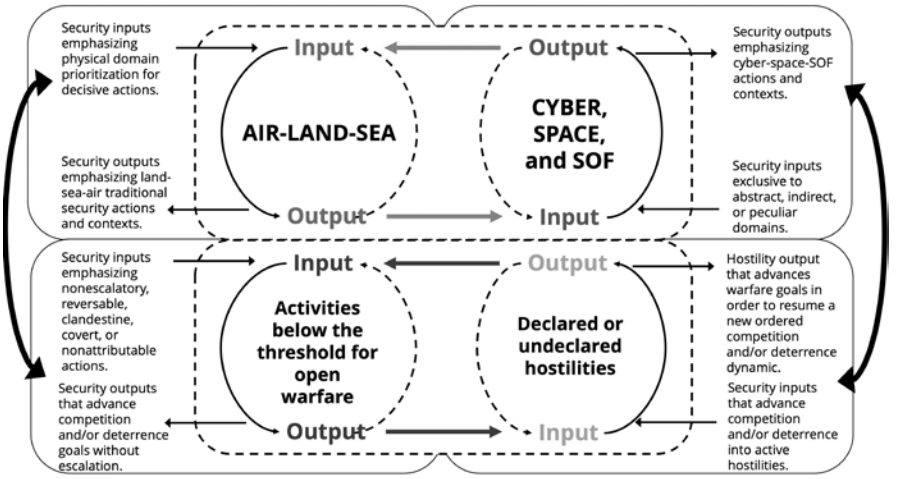
Source: courtesy of author, adapted by MCUP.

expression of "a self-licking ice cream cone" works here and illuminates Klein bottle properties.

Above, the "air-land-sea" and "cyber-space-SOF" dynamic of a single Möbius strip is paired in the same nonorientable topology of a Klein bottle with another Möbius strip security metaphoric device. Here, the spectrum of warfare of original Newtonian styled construct is reimagined in a Möbius fashion where activities below the threshold for open warfare interacts with declared or undeclared hostilities.[85] In earlier metaphoric efforts, the original spectrum of warfare optical, the visible light spectrum entertained a gray zone, which also used the metaphoric device of visualization, or the cones and rods of human perception to explain complex security contexts. The Möbius strip changes that, while the Klein bottle depicted above and in greater detail in figure 12 takes that even further.

Figure 13 must be conceptualized not in a Newtonian stylization where spheres and arrows interact in linear-causal, formulaic, and mechanistic fashion, but *reimagined* through the nonorientable topology of a Klein bottle. The doubling of a Möbius strip may be useful as a metaphoric device so that, as depicted above, the two strips can introduce multiple complex security phenomena that are otherwise oversimplified in Newtonian military doctrine such as the cube example from *Joint Planning*. Figure 13 shows the tensions between the traditional physical domains of air-land-sea and corresponding primary military Services and geographically oriented commands that focus on these interact with the cyberspace, space, and special operations domains/entities/effects that are different, but increasingly significant in explaining contemporary security challenges. In a parallel depiction, a second Möbius strip functions within this

Figure 13. Further along the Möbius: using a Klein bottle for doubling the Möbius (expanded)



Source: courtesy of author, adapted by MCUP.

Klein bottle where cooperation, competition, deterrence, and recognized hostilities (organized violence) moves back and forth, reconceptualizing all the above security concepts into one topological surface stretched and morphed so that it can pour back into itself; security affairs across humanity *need not be arranged exclusively* in a flattened *Mario Brothers* imagined world bound in Newtonian certitude.

With Klein bottles, the outside world has been turned inside, in that the paradoxical, nonlinear, and emergent phenomena of complex reality to include security affairs is no longer oversimplified into categorization buckets such as how the military currently deconstructs complex warfare objectively into reductionist models that are prolific across modern doctrine and training. Militaries continue to seek systematic rendering through Newtonian rationalization such as filtering a complex security challenge into formulaic analysis of political, military, economic, social, informational, and infrastructure (or PMESII), and areas, structures, capabilities, organizations, people, and events (or ASCOPE) as depicted below in a recent U.S. Marine Corps training command graphical aid. Complex warfare is expected to be categorized within the rigid hierarchical, standardized, and mechanical framework found in a 2022 military training illustration. The Klein bottle and other nonorientable topological objects provide an alternative where systematic optimization through objective, analytical reductionism is not the only approach to comprehension and conceptualization.

Klein bottles, as nonorientable surfaces, lack edges or bounds.[86] The bottle dissolves the distinction between inside and outside, as everything that contains the Klein bottle is also contained by it. The Klein bottle is a paradox but also

Figure 14. U.S. Marine Corps Training Command, 2022

	P Political	M Military	E Economic	S Social	I Information	I Infrastructure
A Areas	Areas - Political (District Boundary, Party affiliation areas)	Areas - Military (Coalition / LN bases, historic ambush/IED sites)	Areas - Economic (bazaars, shops, markets)	Areas - Social (parks and other meeting areas)	Areas –Information (Radio/TV/newspapers /where people gather for word-of-mouth)	Areas – Infrastructure (Irrigation networks, water tables, medical coverage)
S Structures	Structures - Political (town halls, government offices)	Structures - Military / Police (police HQ, Military HHQ locations)	Structures - Economic (banks, markets, storage facilities)	Structures - Social (Churches, restaurants, bars, etc.)	Structures - Information (Cell / Radio / TV towers, print shops)	Structures - Infrastructure (roads, bridges, power lines, walls, dams)
C Capabilities	Capabilities - Political (Dispute resolution, Insurgent capabilities)	Capabilities - Military (security posture, strengths and weaknesses)	Capabilities - Economic (access to banks, ability to withstand natural disasters)	Capabilities - Social (Strength of local & national ties)	Capabilities - Info (Literacy rate, availability of media / phone service)	Capabilities - Infrastructure (Ability to build / maintain roads, walls, dams)
O Organizations	Organizations - Political (Political parties and other power brokers, UN,)	Organizations - Military (What units of military, police, insurgent are present)	Organizations - Economic (Banks, large land holders, big businesses)	Organizations - Social (tribes, clans, families, youth groups, NGOs / IGOs)	Organizations - Info (NEWS groups, influential people who pass word)	Organizations - Infrastructure (Government ministries, construction companies)
P People	People - Political (Governors, councils, elders)	People - Military (Leaders from coalition, LN and insurgent forces)	People - Economic (Bankers, landholders, merchants)	People - Social (Religious leaders, influential families	People - Info (Media owners, mullahs, heads of powerful families)	People - Infrastructure Builders, contractors, development councils)
E Events	Events - Political (elections, council meetings)	Events - Military (lethal/nonlethal events, loss of leadership, operations, anniversaries)	Events - Economic (drought, harvest, business open/close)	Events - Social (holidays, weddings, religious days)	Events - Info (IO campaigns, project openings, CIVCAS events)	Events - Infrastructure (road / bridge construction, well digging, scheduled maintenance)

Source: official U.S. Marine Corps data, adapted by MCUP.

a fascinating way to incorporate complexity theory into military thinking, if only to disrupt and perhaps dislodge the dominance of Newtonian rationale on war.[87] There are many ways to play with these ideas that "the Klein bottle is in the world, but, at the same time, the world resides within the Klein bottle" where the traditional military domains of air-land-sea are themselves contained within the vastness of space, while cyberspace is contained within each of these physical (and in space's consideration, supra-physical) domains, yet warfare can exercise entirely inside of cyberspace while directly impacting the physical reality of humanity in profound, even devastating ways that arguably compare to the horrors of many physical acts of warfare. We cannot conceptualize cyberspace, space, and special operations activities across multiple domains in complex warfare if we are entirely reliant on a Newtonian war paradigm that prescribes Newtonian graphics exclusively. Complex warfare requires not only new ways of rendering these concepts in two-dimensional doctrine and theory, but a paradigmatic shift in how we understand war itself beyond contemporary limits.

Metaphorically, Klein bottles might better adapt to the paradoxical experience of time and space, history, and social construction of reality and how humans live both in an objective, tangible physical reality while also existing in a shared, conceptualized, and highly subjective second order of complexity that denotes human existence.[88] Victor Donas, in adapting Klein bottles to a political science and psychoanalytical approach explains:

> The Klein Bottle/Surface has no in-and-out frontier, it is shaped as a tridimensional moving field, it flows within itself in a rhythm of pulses.

> It entangles the individual with the multiple, the width of its borders reaches out toward alterity, but it returns to itself in a never ending reentry loop. We can also use it as a representation of time and history, the movement of a surface toward becoming in the present that emerges from the landmarks of what has been lived, only to flow again and reenter in the timeline of the past.[89]

Complex warfare, articulated to military forces using nonorientable objects as metaphoric devices, could offer far more latitude in how complexity theory, systems theory, social paradigm theory, and postmodern concepts might be assimilated into how and why security forces understand conflict in novel, unrealized ways. This does require significant revision, reframing, and retirement of nearly all modern military doctrine, complete with reconceptualization of the primary military theories, models, methodologies, and the very terminology that largely converge toward a shared Newtonian fetishization of understanding complex warfare.

Considering the Human-Machine Team at Ontological and Epistemological Levels

This last section briefly addresses how human operators in military organizations now, more than ever, are pairing with machines equipped with ever-increasing sophisticated artificial intelligence (AI). Historically, the tools of war were designed by humans and utilized for battlefield advantage by human controllers. The first horse stirrup, the cavalry sword, or the first functioning firearm are war tools that are means to a human-designed military end state. The atomic bomb and the first spear represent the same general application of organized violence directed at opponents by a human aggressor in war. Yet, we are as a species about to enter an entirely new reality where the war tools we design will become increasingly capable of redesigning our programmed ends into new, emergent ends of their own creation.[90] Whether we can control or prevent advanced AI from deviating from our designed military goals and their specific roles in accomplishing them is for another discussion. Here, the emergence of human-machine teams in future conflict will increasingly have a lopsided relationship in cognitive ability, scale, and speed. Tomorrow's AI system will gain and rapidly exceed even the smartest human on the battlefield, while also able to operate at vast scales and speeds that might make us seem as if we are moving in slow motion.

Given that we as humans seek to remain in control and fully aware of any military human-machine team, the dynamics of this emerging warfighter relationship presents exceptional opportunities if we can break past our dependence on the Newtonian war paradigm. Currently, most AI programming for military applications retains our preferred understanding of social reality. We prompt our AI systems by feeding them our doctrine, instructing them to learn from published policy, historical accounts, or military methodologies that again

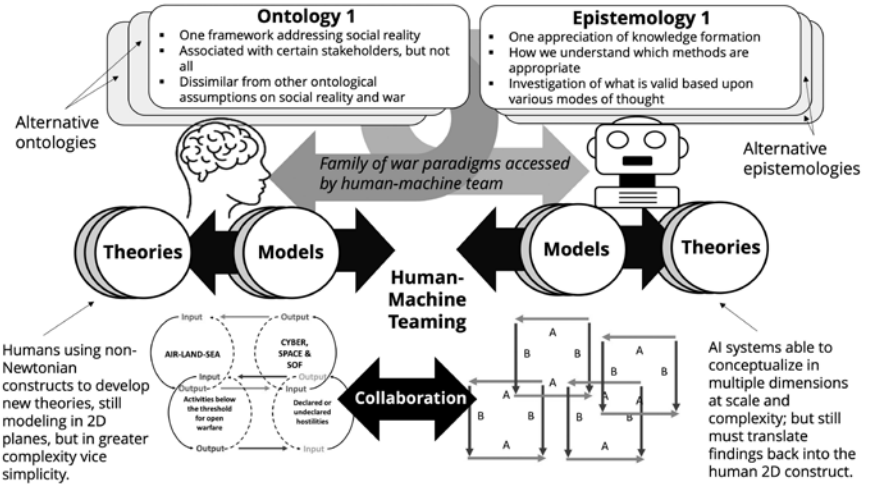
are entirely rendered in a specific war paradigm. Although this does not at all mean that AI, particularly advanced AI or even general intelligence AI, must conceptualize things exactly as we currently do, current human-machine teams are largely stuck in using existing doctrine, theory, and models. Teams operating in cyberspace, considering military activities in the space domain, or combining these in an all-domain, challenging arrangement of forces and systems with many organizations (combining human and AI together) are required to work as warfighters in what remains a Newtonian stylization of complex reality.

Skeptics might posit fairly that Möbius strips and Klein bottles presented thus far are all very interesting, but largely useless for the bulk of military forces. How could a captain in a division joint operations center, or a sergeant working as part of an aviation crew equipped with robust AI systems actually benefit from these non-Newtonian constructs? What if the average human operator simply cannot think beyond the familiar Newtonian shapes and models? This is a fair point, but one that illuminates why human-machine teams should operate differently in future wars. Humans do prefer two-dimensional constructs because they simplify reality sufficiently so that we can usually accomplish what we need. Everything in figures 4–6 can be argued as sufficient for most all modern conflicts, whether the winner or loser is using them. Victorious forces beat their opponents using them, and while some conflicts featured technologically sophisticated AI systems in various manifestations, how those tools were employed were conceptualized using the same Newtonian frame. While the Taliban ultimately defeated Western-backed Afghan forces and suffered tremendous tactical losses for two decades by American led forces equipped with some of the best AI systems in modern warfare, the same systems were managed and set in a strategy dominated by the Newtonian war paradigm. In other words, Westerners had the most lethal, precise, sophisticated weaponry on the planet, but the ontological and epistemological assumptions underlying how we used such tools was quite similar to the technologically primitive Taliban.[91]

In figure 15, the human operator is positioned on the left, and the artificial intelligent system on the right. If we utilize multiple paradigms for a range of war frames, and the computer programmers enable this in the AI system, the human operator can continue to interpret complex reality using what likely will be a Newtonian stylization, or perhaps a modified war frame that uses some non-Newtonian constructs such as Möbius strips and Klein bottles (or other non-Newtonian models). The AI system can operate across a broader range of war paradigms, conceptualizing in multiple dimensions, and offering entirely novel concepts and suggestions to the human operator. In other words, an AI weapon system represents for the first time in human history the potentiality for a human designed tool to generate new ends not anticipated or even comprehended by the designer. This puts war into uncharted territory, where the AI system will still need to articulate new constructs back to the human user, even if there is loss in the depth or sophistication due to human limitations.

Multidimensional or non-Newtonian constructs still must "bridge"

Figure 15. Shifting from a Newtonian to a multiparadigmatic framing for war



Source: courtesy of author, adapted by MCUP.

across to the human operator and ultimately be comprehended in some familiar two-dimensional configuration for maximum understanding. Yet, in the proposed human-machine team dynamic below, the AI is liberated from the Newtonian war paradigm and granted the ability to provide the human decision-maker with new and innovative options that will require the human to think beyond existing institutionalized limits. The space-SOF-cyber construct should not be oversimplified into a triangle, nor should multi-domain conflict be conceived as a layered static cube (see figure 2). Human designed ends-ways-means operational planning and strategies might be utilized within formations, but the AI systems working in tandem need not limit themselves with these oversimplifications of how complex reality actually emerges in time and space.

Figure 15 is one way that we ought to consider how humans and intelligent machines cooperate in complex warfare. Even if the AI system is doing something the human programmers cannot explain or link back to their original coding, that AI should attempt to present these new ideas and opportunities in ways that violate existing military doctrine, theory, models, and our overarching belief system. The Newtonian war paradigm essentially dies here, to be replaced by a new one that must be designed collaboratively with humanity and the intelligent machines we are bringing into reality today. There are clear ethical, moral, and legal concerns with advanced or general AI, yet the anticipated arms race between various competing or antagonistic societies will not cease simply because AI could become the genie we let out of the bottle (or battle).[92] Adversaries are already designing human and AI collaboration in all military domains across all possible security applications and weapon systems.

Current efforts in pairing AI with human decision-makers for strategy, op-

erations, and tactics are potentially insufficient if they retain a single-paradigm, Newtonian-fixated orientation. This would mutate the above graphic to one where figure 1 has the human imposing their singular war paradigm upon all possible activities the AI might conduct. Instead, we must consider a bridge where both the human operator and the AI system can access a multitude of useful, yet alternative war paradigms. In some cases, the human might come up with an innovative option and request the AI system to develop it further. In others, the AI will be conceptualizing beyond human abilities, likely in multiple dimensions and at a scale and speed unprecedented in the history of war. Those human-machine teams that can best utilize such an arrangement can ultimately produce decisive military action that is not artificially limited by one war paradigm or another. We need not make intelligent machines think about organized violence using triangles, triads, ends-ways-means, or centers of gravity. Indeed, they may be the ultimate tool for liberating the modern military profession from five centuries of increasingly insufficient and obsolete thinking on war.

Conclusions: Shifting Away from a Westphalian Nation-State Centric War Frame

This article was written as a thought piece to stimulate debate in the military profession on how and why the institution conceptualizes warfare, and whether many efforts to innovate are stymied not by the lack of vision of those creative thinkers, but by the overarching and often unquestioned institutional paradigm that directs new concepts to be articulated using the preferred cognitive tools, models, and terminology that hold to a particular (and, arguably, quite limited) view of warfare. Innovation is fine if it uses the doctrinal language, is illustrated in two-dimensional renderings dependent on basic geometric concepts shared by the institution, and relies on the very same theoretical and methodological offerings that all other existing doctrinal concepts utilize. This means that acts of military innovation must clear the paradoxically high bar of both critiquing and also *still validating* the very ideas that are under critical examination for retirement or replacement! To accomplish this difficult task, this article operates first and foremost from a philosophical level. The discussions on ontology and epistemology are essential for explaining why we stick to a certain war paradigm and how we might think our ways out of it.

It needs to be restated that conceptualizing complex reality using topological concepts as metaphoric devices is not new, except perhaps to most security forces who remain tightly wedded to ontologically flattened, Newtonian engineered constructs for making sense of war.[93] Postmodern theorists such as Gilles Deleuze have for decades taken concepts such as the Möbius strip "with its continual repetitions of seemingly dualistic terms . . . not in order to produce a reductionist form of dualistic thinking but in order to put it into conversation, to put it in the place of a problem."[94] Postmodern critiques and deconstructions remain largely inaccessible to the modern military profession, arguably due to particularly insular, even anti-intellectual stances dominant across the

dominant professional military education system.[95] However, postmodern experimentation has been attempted in select complex military operations since the late 1990s, starting first in the Israeli Defense Forces and building into what today is a recognized, international "military design movement."[96]

One of the most cited examples of this mode of reframing thought and action in warfare comes from a 2002 Israeli infantry operation against enemy forces entrenched in urban neighborhoods in Balata. Colonel Aviv Kochavi, a former student of Dr. Shimon Naveh and this postmodern way of warfare would reconceptualize his unit's mission in what he termed "fractal geometry."[97] His metaphor of "a worm eating its way through the apple" explained his idea to invert the urban terrain and have his forces "walk through walls" by turning buildings into maneuver corridors and avoiding the well-prepared kill boxes outside in the streets.[98] Indeed, Kochavi's concept provides tactical and operational examples of the Möbius strip and Klein bottles with how they reimagined their difficult mission to clear the enemy from a well-defended cityscape by abandoning traditional views of geometry and warfare.[99]

Introducing topological concepts as new metaphoric devices for reimagining complex warfare opens the door for many previously off limits or institutionally ignored fields, disciplines, and theories to be incorporated in meaningful ways into warfare frames.[100] While postmodernism plays the intellectual boogieman for traditional Newtonian military purists, the overemphasis of the Newtonian objectivist ontology, mechanistic epistemology, and instrumental praxeology only function to reinforce institutionalized war beliefs. These are that all wars across time and space, future and past can be frozen in time, isolated, reduced, analyzed through inductive and deductive reasoning, and then reverse-engineered with clear precision for military forces fixated on risk reduction, uniformity, best practices, and rigorously institutionalized patterns of known behaviors. The Möbius strip and Klein bottles act to disrupt, soften, and challenge these near ideological stances on complex warfare. New metaphoric devices and language need to be paired with this proposed shift in conceptualizing warfare, with worms and apples, *Pac-Man* and twisting paper belts requiring new ways of thinking beyond triangles, triads, cubes, and two-dimensionally limited constructs.

In closing, the suggestion to shift away from rigid, two-dimensional conceptualizations and metaphoric devices such as cubes, closed lines and loops, triangles, and fixed geometry does not substitute one *oversimplified* concept with an overly *complicated* one. The metaphoric devices, models, and terminology themselves are merely tools used to activate deeper theories and methods that, in keeping with shared belief systems, sustain a social paradigm (how we know what war is, and how we know what to do within warfare to get what we desire). The notion to disrupt, challenge, and replace how we conceptualize our models and metaphoric devices in addressing complex warfare is less about techniques or graphics in the next doctrinal publication and far more about how an organization *thinks about its own thinking* about war. Deleuze and others pursue this

by morphing an organization's conceptual frame at deep philosophical levels, in that "a Deleuzian 'geophilosophy' takes space as neither the ground nor the object of analysis but rather as a condition for thought itself."[101]

Militaries need not convert themselves into postmodern theorists to realize warfare differently, but they ought not shun entire disciplines and fields such as complexity theory, quantum theory, systems theory, social paradigm theory, and postmodern philosophy because they require new language, concepts, and theories to process. The end of the Newtonian paradigm for warfare is here, if not well past. Everything in warfare need not be forced into some *Donkey Kong* plane of existence, as the next generation of military professionals already operate immersed in multiple dimensions of entertainment, culture, and complex reality whether through virtual, augmented, or tangible means. Future generations of military professionals will drift away from such oversimplification and static, reductionist renderings of complex security affairs, likely with new education as well as technological advancements in artificial intelligence, human-machine teaming, and a complete introspection of how and why militaries could become so trapped in particular ways of thinking about warfare so that alternatives remain off limits.

Endnotes

1. Carl Builder, *The Masks of War: American Military Styles in Strategy and Analysis* (Baltimore, MD: Johns Hopkins University Press, 1989).
2. Another useful way to distinguish between tacit and explicit knowledge is when someone needs to move over so we can do whatever task is being asked, as "we know how to do it, but explaining it takes too long."
3. Haridimos Tsoukas, *Complex Knowledge: Studies in Organizational Epistemology* (New York: Oxford University Press, 2005), 213–16.
4. Ben Zweibelson, "War Becoming Phantasmal: A Cognitive Shift in Organized Violence Beyond Traditional Limits," *Expeditions with MCUP*, forthcoming 2024.
5. Early Greek concepts would inspire seventeenth century scientific reforms that would displace and challenge the "premodern" through a new "scientific rationalism." Lorraine Daston, *Rules: A Short History of What We Live By* (Princeton, NJ: Princeton University Press, 2022), 233–34.
6. Marianne Lewis and Mihaela Kelemen, "Multiparadigm Inquiry: Exploring Organizational Pluralism and Paradox," *Human Relations* 55, no. 2 (2002): 251–75, https://doi.org/10.1177/0018726702055002185; Majken Schultz and Mary Jo Hatch, "Living with Multiple Paradigms: The Case of Paradigm Interplay in Organizational Culture Studies," *Academy of Management Review* 21, no. 2 (1996): 529–57, https://doi.org/10.5465/amr.1996.9605060221; and Colin Clarke-Hill, Huaning Li, and Barry Davies, "The Paradox of Co-Operation and Competition in Strategic Alliances: Towards a Multi-Paradigm Approach," *Management Research News* 26, no. 1 (2003): 1–20, https://doi.org/10.1108/01409170310783376.
7. Gen Stanley A. McChrystal et al., *Team of Teams: New Rules of Engagement for a Complex World* (New York: Portfolio, 2015), 57.
8. Christopher Paparone, *The Sociology of Military Science: Prospects for Postinstitutional Military Design* (New York: Bloomsbury Academic Publishing, 2013); Ben Zweibelson, *Understanding the Military Design Movement: War, Change and Innovation* (New York: Routledge, 2023); Ben Zweibelson, *Beyond the Pale: Designing Military Decision-Making Anew* (Maxwell Air Force Base, AL: Air University Press, 2023); Jamshid Ghara-

jedaghi, *Systems Thinking: Managing Chaos and Complexity: A Platform for Designing Business Architecture*, 3d ed. (New York: Elsevier, 2011); Jamshid Gharajedaghi and Russell Ackoff, "Mechanisms, Organisms, and Social Systems," in Haridimos Tsoukas, *New Thinking in Organizational Behaviour* (Oxford, UK: Butterworth-Heinemann, 1994), 25–49; Russell Ackoff, "On the Use of Models in Corporate Planning," *Strategic Management Journal* 2, no. 4 (December 1981): 353–59; Tsoukas, *Complex Knowledge*; and Haridimos Tsoukas, "A Dialogical Approach to the Creation of New Knowledge in Organizations," *Organization Science* 20, no. 6 (December 2009): 941–57.

9. Gary Weaver and Dennis Gioia, "Paradigms Lost: Incommensurability vs Structurationist Inquiry," *Organization Studies* 15, no. 4 (1994): 565–90, https://doi.org/10.1177/017084069401500040; Norman Jackson and Pippa Carter, "In Defence of Paradigm Incommensurability," *Organization Studies* 12, no. 1 (1991): 109–27, https://doi.org/10.1177/017084069101200107; and Dennis Gioia and Evelyn Pitre, "Multiparadigm Perspectives on Theory Building," *Academy of Management Review* 15, no. 4 (1990): 584–85.
10. The author, as a former "opposing forces" company commander and operations group planner at the Joint Readiness Training Center in Fort Polk, LA, wrote a thought piece specifically on this topic. See Ben Zweibelson, "Preferring Copies with No Originals: Does the Army Training Strategy Train to Fail?," *Military Review*, February 2014, 15–25.
11. Tsoukas, *Complex Knowledge*, 213–14.
12. Christopher Paparone and James Crupi, "The Principles of War as Paradox," U.S. Naval Institute *Proceedings* 131, no. 10 (October 2005): 39–44; Ben Zweibelson, "Gravity-Free Decision-Making: Avoiding Clausewitz's Strategic Pull," *Directorate of Future Land Warfare, Australian Department of Defence*, Army Research Papers no. 8 (Canberra: Australian Army Research Centre, 2015): 60; and Zweibelson, *Beyond the Pale*, 47–97.
13. Tsoukas, *Complex Knowledge*, 213.
14. Antoine Bousquet, "Chaoplexic Warfare or the Future of Military Organization," *International Affairs (Royal Institute of International Affairs 1944–)* 84, no. 5 (September 2008): 919; James Der Derian, "Virtuous War/Virtual Theory," *International Affairs (Royal Institute of International Affairs 1944–)* 76, no. 4 (October 2000): 786; and Paparone, *The Sociology of Military Science*, 18–20.
15. Sebastien Le Prestre de Vauban, *The New Method of Fortification, as Practised by Monsieur de Vauban, Engineer-General of France. Together With a New Treatise of Geometry, the Fifth Edition, Carefully Revised and Corrected by the Original* (London: S. and E. Ballard, 1722; Farmington Hills, MI: Gale Ecco, 2018); and Henry Guerlac, "Vauban: The Impact of Science on War," in *Makers of Modern Strategy: From Machiavelli to the Nuclear Age*, ed. Peter Paret (Princeton, NJ: Princeton University Press, 1986).
16. Tsoukas, *Complex Knowledge*, 212–14, 240.
17. The term *interplay* is used by Schultz and Hatch in a specific manner for multiple paradigms. Interplay refers to new and emergent collaborative outputs that are achieved through two or more social paradigms and otherwise are inaccessible by just one of the paradigms independently. See Schultz and Hatch, "Living with Multiple Paradigms"; and Ben Zweibelson, "The Multidisciplinary Design Movement: A Frame for Realizing Industry, Security, and Academia Interplay," *Small Wars Journal*, January 2019.
18. Karl Weick, "Drop Your Tools: An Allegory for Organizational Studies," *Administrative Science Quarterly* 41, no. 2 (1996): 301–13, https://doi.org/10.2307/2393722.
19. The author, as an operational planner at the Joint Readiness Training Center in 2006, witnessed an evaluation team mentor, an infantry battalion commander, who refused to use linear planning doctrine because he felt his previous Iraqi deployments rendered them irrelevant. The evaluating task force seniors devised the "football plays toward the endzone" construct to placate the commander (a football enthusiast) but continue the same planning processes they needed to evaluate the battalion with. This is an excellent example of swapping out terminology and models while holding to the same theories and overarching paradigmatic belief system.

20. Of the Napoleonic war theorists, only Clausewitz would incorporate German Romanticism and German Idealism into his theories. These were available to him and others in the late eighteenth through nineteenth centuries, yet the scientific discipline of sociology was only just commencing in the mid-nineteenth century. Complexity science, quantum theory, and other twentieth century revelations would be entirely inaccessible. On Clausewitz's unique fusion of Enlightenment science with German Idealism, see Peter Paret, *Clausewitz and the State: The Man, His Theories, and His Times* (Princeton, NJ: Princeton University Press, 1985), 7, 156, 196–97; Gibson Burrell and Gareth Morgan, *Sociological Paradigms and Organisational Analysis: Elements of the Sociology of Corporate Life* (Portsmouth, NH: Heinemann, 1979), 69; and Peter Paret, "The Genesis of *On War*," in Carl von Clausewitz, *On War*, ed. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1984), 11.
21. This section draws extensively from the author's current book in development. Tentatively titled *[Re]Conceptualizing War*, the author summarizes key points from the first chapter here with several paragraphs incorporated here from the current draft chapter. Thomas Kuhn, *The Structure of Scientific Revolutions*, 3d ed. (Chicago: University of Chicago Press, 1996).
22. War's effects are experienced objectively in physical reality through destruction, death, and harm to any living creatures and inanimate objects impacted, but also subjectively in how war damages living creatures in ways that can be seen as well as in many invisible forms. If just the physical, tangible effects of war are considered, these occur entirely in the physical reality that might be divorced from the social reality within which living, intelligent beings perceive and interpret another part of the world.
23. Lewis and Kelemen, "Multiparadigm Inquiry," 252.
24. Siniša Malešević, *The Sociology of War and Violence* (Cambridge, UK: Cambridge University Press, 2010), 314, https://doi.org/10.1017/CBO9780511777752.
25. Yuval Harari, *Sapiens: A Brief History of Humankind* (New York: Harper Perennial, 2018), 110.
26. Gareth Morgan, "Exploring Plato's Cave: Organizations as Psychic Prisons," in *Images of Organizations* (San Francisco, CA: Sage Publications, 2006), 226.
27. Burrell and Morgan, *Sociological Paradigms and Organisational Analysis*, 1; and Robert Chia, "Teaching Paradigm Shifting in Management Education: University Business Schools and the Entrepreneurial Imagination," *Journal of Management Studies* 33, no. 4 (July 1996): 414, https://doi.org/10.1111/j.1467-6486.1996.tb00162.x.
28. Zweibelson, *Beyond the Pale*, 56–64.
29. Specifically, ontology addresses what we as humans declare cognitively is real. If one holds a hammer, we ontologically know what a hammer is, even if this particular hammer looks different from most other hammers. If we accidentally hit our fingers while using it, we know that pain is real too, even though you can hand another person the hammer, but you cannot give the other person the precise pain you are experiencing, even if you struck their hand with the same hammer. We experience pain subjectively, but we all ontologically agree that pain exists despite us each having our own contextually unique understanding.
30. Burrell and Morgan, *Sociological Paradigms and Organisational Analysis*, 1; and Lewis and Kelemen, "Multiparadigm Inquiry," 255.
31. Lewis and Kelemen, "Multiparadigm Inquiry," 255; and Shirley-Ann Hazlett, Rodney McAdam, and Seamus Gallagher, "Theory Building in Knowledge Management: In Search of Paradigms," *Journal of Management Inquiry* 14, no. 1 (March 2005): 32, https://doi.org/10.1177/1056492604273730.
32. This is a simplified introduction to social paradigms for military organizations. A deeper study is available in Zweibelson, *Beyond the Pale*, 52–68.
33. John Shy, "Jomini," in *Makers of Modern Strategy*, 144–46, 161; and Beatrice Heuser, *Reading Clausewitz* (London, UK: Pimlico, 2002), 76–77.
34. Special Forces do not own a particular domain, while military forces assigned to space and cyberspace may not be the only entities acting within them for security or national designs. Thus, the model is simplistic and, in some ways, misleading. The space-SOF-

cyber triad is not nearly as simple as the triangle model suggests. However, for the purposes of explaining the concepts to the broader Department of Defense forces, these military organizations selected a triad as one of several ways to graphically model the arrangement.

35. Julian Jaynes, *The Origin of Consciousness in the Breakdown of the Bicameral Mind*, 3d ed. (Boston, MA: First Mariner Books, 2000), 53.
36. Ben Zweibelson, "Why Do Militaries Stifle New Ideas?," *Contemporary Issues in Air & Space Power* 2, no. 1 (2024): 1–6.
37. Christopher Paparone, "On Metaphors We Are Led By," *Military Review* 88, no. 6 (December 2008): 55–64; Paparone and Crupi, "The Principles of War as Paradox"; and Christopher Paparone, "Beyond Ends-Based Rationality: A Quad-Conceptual View of Strategic Reasoning for Professional Military Education," Research Gate, 16 May 2016, 309–47; Christopher Paparone, "How We Fight: A Critical Exploration of US Military Doctrine," *Organization* 24, no. 4 (2017): 516–33, https://doi.org/107.171/1773/51035058048147167699338 53.
38. Paret, *Clausewitz and the State*, 369; and Antoine Bousquet, *The Scientific Way of Warfare: Order and Chaos on the Battlefields of Modernity* (London: Hurst Publishers, 2009), 13; and Malešević, *The Sociology of War and Violence*, 174.
39. Herbert Rosinski, *Power and Human Destiny*, 1st ed. (New York: Frederick A. Praeger, 1965), 151. Emphasis added.
40. *Joint Planning,* Joint Publication 5-0 (Washington, DC: Department of Defense, 2020), 164.
41. Not to confuse Kuhnian paradigm shifts with social paradigms, the rise of Newtonian science caused major societal changes outside of the European civilization accepting a scientific rationalization on reality. The debates on whether the Sun orbited this planet or if Earth and other planets orbited the Sun reflects the difficult social and scientific shift from one mode of thinking to another.
42. Bousquet, *The Scientific Way of Warfare*, 40–41; and Paparone, "On Metaphors We Are Led By," 55–58.
43. Although ancient Greek phalanxes seem nothing like a modern infantry platoon today, the fundamentals of maneuvering on land toward a specific objective and seizing it with a combination of different weaponry and attacks against a defender remain basically similar in execution. The medieval knight charging on horseback would seem eerily similar to the early twentieth century cavalry charges, while ancient ships waging maritime war would basically pursue similar warfighting objectives to their modern counterparts of the twentieth century. While the "why" of war should continuously be debated, the "how" of warfare appears more stable over great periods of time.
44. Zweibelson, *Understanding the Military Design Movement*, 63–76.
45. Daston, *Rules*, 216.
46. David French, *The British War in Warfare, 1688–2000* (Cambridge, MA: Unwin Hyman, 1990), 2.
47. Martin van Creveld, *The Training of Officers: From Professionalism to Irrelevance* (New York: Free Press, 1990), 13.
48. C. C. Pecknold, "How Augustine Used the Trinity: Functionalism and the Development of Doctrine," *Anglican Theological Review* 85, no. 1 (Winter 2003): 131.
49. David Lindberg, *The Beginnings of Western Science: The European Scientific Tradition in Philosophical, Religious, and Institutional Context, 600 B.C. to A.D. 1450* (Chicago: University of Chicago Press, 1992), 85–131.
50. Lindberg, *The Beginnings of Western Science*, 190–91.
51. The duality of ritualization and historically validated practices in war cannot be understated in premodern societies. Nearly every aspect of war carried clear examples of ontological and epistemological assumptions that this world required specific activities for supernatural ends. The blessings by clerics before battle, the use of religious artifacts, symbols, and banners on uniforms or presented by forces, and the last rites offered to fallen warriors are all examples of shared belief systems concerning war. Visions, oracles, dreams, divine edicts, prayers, and interpreted signs from a higher power

would influence military decision-making, while each society often paired the justification to wage war and inflict violence upon others in ideological reasoning, referring to divine texts. For feudal Europe, this combination of church and state interest would make most military affairs a joint effort with clear consequences and benefits to both groups.

52. *DOD Dictionary of Military and Associated Terms* (Washington, DC: U.S. Joint Staff, 2007), 169.
53. Chris Paparone, *The Sociology of Military Science: Prospects for Postinstitutional Military Design* (New York: Bloomsbury, 2013), 18–19.
54. Der Derian, "Virtuous War/Virtual Theory," 786.
55. Paparone, *The Sociology of Military Science*, 20.
56. Zweibelson, *Beyond the Pale*, 97–137.
57. J. F. C. Fuller, *The Foundations of the Science of War* (London: Hutchinson, 1925; Newbury, UK: Books Express Publishing, 2012), 43. Citations refer to the Books Express Publishing edition.
58. Fuller, *The Foundations of the Science of War*, 38.
59. Fuller, *The Foundations of the Science of War*, 43–44.
60. Fuller, *The Foundations of the Science of War*, 18. Fuller would embrace attempts to extend Darwin's theory into sociology, often called "social Darwinism" that became popular in the late nineteenth and early twentieth century. War could, for Fuller, become manageable and predictable if a combination of Newtonian and Darwinian processes were rigidly applied.
61. Fuller, *The Foundations of the Science of War*, 45.
62. Jaynes, *The Origin of Consciousness in the Breakdown of the Bicameral Mind*, 2–3.
63. Shimon Naveh, Jim Schneider, and Timothy Challans, *The Structure of Operational Revolution: A Prolegomena* (Fort Leavenworth, KS: Booz Allen Hamilton, 2009), 35–36.
64. While the generals of the American Civil War would not readily grasp computers, atomic weapons, or aircraft carriers, they would likely understand all of the general concepts illustrated in figures 4–6, and once the advanced technology were explained, appreciate how these concepts can be articulated and depicted in Newtonian logical arrangements.
65. Grant Martin, "Of Garbage Cans and Paradox: Reflexively Reviewing Design, Mission Command, and the Gray Zone," *Journal of Military and Strategic Studies* 17, no. 4 (2017): 201.
66. Topology would not consider the Möbius strip normal or abnormal. Again, the metaphoric content here is applied to the military profession thinking not about mathematics, but war.
67. Lyn Robinson and Mike McGuire, "The Rhizome and the Tree: Changing Metaphors for Information Organisation," *Journal of Documentation* 66, no. 4 (2010): 604.
68. Sun Tzu, *The Art of War: Complete Text of Sun Tzu's Classics, Military Strategy History, Ancient Chinese Military Strategist Deluxe Collection Edition*, trans. Lionel Giles (Las Vegas, NV: independently published, 2022), 60–61.
69. Aaron Jackson, *The Roots of Military Doctrine: Change and Continuity in Understanding the Practice of Warfare* (Fort Leavenworth, KS: Combat Studies Institute Press, 2013); and Felix Gilbert, "Machiavelli: The Renaissance of the Art of War," in *Makers of Modern Strategy: From Machiavelli to the Nuclear Age*, ed. Peter Paret (Princeton, NJ: Princeton University Press, 1986), 11.
70. Bousquet, "Chaoplexic Warfare or the Future of Military Organization," 919.
71. Jeffrey Meiser, "Ends + Ways + Means = (Bad) Strategy," *Parameters* 46, no. 4 (Winter 2016): 81–91, https://doi.org/10.55540/0031-1723.3000; Paparone, "Beyond Ends-Based Rationality"; Ben Zweibelson, "One Piece at a Time: Why Linear Planning and Institutionalisms Promote Military Campaign Failures," *Defence Studies Journal* 15, no. 4 (2015): 360–75, https://doi.org/10.1080/14702436.2015.1113667; and Ben Zweibelson, "Linear and Nonlinear Thinking: Beyond Reverse-Engineering," *Canadian Military Journal* 16, no. 2 (2016): 27–35.
72. Reginald Litz, "Two Sides of a One-Sided Phenomenon: Conceptualizing the Fam-

ily Business and Business Family as a Möbius Strip," *Family Business Review* 21, no. 3 (September 2008): 217–36, https://doi.org/10.1111/j.1741-6248.2008.00124.x; Hunter Dukes, "Beckett's Vessels and the Animation of Containers," *Journal of Modern Literature* 40, no. 4 (2017): 75–89, https://doi.org/10.2979/jmodelite.40.4.06; Jill Ratzan and Lee Ratzan, "Möbius Strips, Klein Bottles, and Dedications: The Mathematics of a Series of Unfortunate Events," *Children and Libraries*, Spring 2005; Victor Donas, "The Message of a Bottle: A Discussion of 'Trump Cards and Klein Bottles: On the Collective of the Individual'," *Psychoanalytic Dialogues* 30, no. 4 (2020): 408–16, https://doi.org/10.1080/10481885.2020.1774331; Julyan Cartwright and Diego Gonzalez, "Möbius Strips Before Möbius: Topological Hints in Ancient Representations," *Mathematical Intelligencier*, no. 38 (2016): 69–76, https://doi.org/10.1007/s00283-016-9631-8; Renzo Caddeo, Stefano Montaldo, and Paola Piu, "The Möbius Strip and Viviani's Windows," *Mathematical Intelligencer*, no. 23 (2001); Daniel Cockayne, Derek Ruez, and Anna Secor, "Thinking Space Differently: Deleuze's Möbius Topology for a Theorisation of the Encounter," *Transactions of the Institute of British Geographers* 45, no. 1 (2020): 194–207, https://doi.org/10.1111/tran.12311; and Bernadette Barton, "Dancing on the Möbius Strip: Challenging the Sex War Paradigm," *Gender and Society* 16, no. 5 (October 2002): 585–602.

73. This refers to the metaphoric devices and does not imply that in a strict mathematical sense, a nonorientable surface is more complex than an orientable surface. For the purposes of conceptualizing warfare, only orientable, standard geometric constructs have been utilized for many centuries of military theory and practice.
74. The Möbius strip can also be cut into six different mutually adjacent regions due to the Möbius strip not being an orientable plane. This could offer military theorists a multitude of ways to conceptualize the complex interaction of military domains, different forms and functions of organized violence, the arrangement of actions and effects across various agencies and partners, or something entirely different that still adheres to the unique properties of the Möbius strip.
75. Tsoukas, *Complex Knowledge*, 217.
76. Boyd's OODA loop is a conceptual model still grounded in a Newtonian rationale, while military campaign planning reflects more of the mechanistic epistemology and objectivist ontology where "A plus B leads to C." The "ends-ways-means" construct is an epistemological framework for the modern technical-rationalist "military paradigm."
77. Ben Zweibelson, *Reconceptualizing the Space Domain Beyond Historic Perspectives of Warfare*, Schriever Papers no. 1 (Maxwell AFB, AL: Air University Press, 2023), 1–66; Ben Zweibelson, "PART I: The Singleton Paradox: On the Future of Human-Machine Teaming and Potential Disruption of War Itself," *Journal of Advanced Military Studies* 14, no. 1 (Spring 2023): 11–46, https://doi.org/10.21140/mcuj.20231401001; and Ben Zweibelson, "PART II: Whale Songs of Wars Not Yet Waged: The Demise of Natural-Born Killers through Human-Machine Teamings Yet to Come," *Journal of Advanced Military Studies* 14, no. 1 (Spring 2023): 47–82, https://doi.org/10.21140/mcuj.20231401002.
78. This figure and many subsequent ones in this article draw direct inspiration from the original graphics of Möbius strip configurations in Litz, "Two Sides of a One-Sided Phenomenon."
79. Maia Averett, "Mathematical Cut-And-Paste: An Introduction to the Topology of Surfaces," *Pi in the Sky*, no. 21 (Spring 2019): 6.
80. Diego Rapoport, "Surmounting the Cartesian Cut through Philosophy, Physics, Logic, Cybernetics, and Geometry: Self-Reference, Torsion, the Klein Bottle, the Time Operator, Multivalued Logics and Quantum Mechanics," *Foundations of Physics*, no. 41 (2011): 46–47, https://doi.org/10.1007/s10701-009-9334-5.
81. Again, mathematically a three-dimensional rendered Klein bottle does violate certain topological principles, but when used as a metaphoric device or adapted to create interesting glass sculptures in the real world, the ideas generated by a Klein bottle can help shift conceptualization into new, unexplored areas.

82. *The Moscow Mechanism Report on Russia's Failure to Fulfill Its Human Dimension Commitments* (Washington, DC: U.S. State Department, 2022).
83. Mary Jo Hatch and Dvora Yanow, "Methodology by Metaphor: Ways of Seeing in Painting and Research," *Organization Studies* 29, no. 1 (2008): 23–44, https://doi.org/10.1177/0170840607086635; Antoine Bousquet and Simon Curtis, "Beyond Models and Metaphors: Complexity Theory, Systems Thinking and International Relations," *Cambridge Review of International Affairs* 24, no. 1 (2011): 43–62, https://doi.org/10.1080/09557571.2011.558054;
84. Ann Jones, "Woman to Woman in Afghanistan: Female Engagement Teams Joint the Counterinsurgency," *Nation*, 27 October 2010.
85. *Operations*, Field Manual 3-0 (Washington, DC: Headquarters, Department of the Army, 2008), 2–5. In this version of FM 3-0, the U.S. Army uses an electromagnetic spectrum metaphoric device to illustrate the concept of a "spectrum of warfare" behaving as light does in physics.
86. Richard Brown, "The Klein Bottle as an Eggbeater," *Mathematics Magazine* 46, no. 5 (1973): 244–46, https://doi.org/10.1080/0025570X.1973.11976328.
87. Dukes, "Beckett's Vessels and the Animation of Containers," 83.
88. Haridimos Tsoukas and Mary Jo Hatch, "Complex Thinking, Complex Practice: The Case for a Narrative Approach to Organizational Complexity," *Human Relations* 54, no. 8 (August 2001): 979–1013, https://doi.org/10.1177/0018726701548001; Schultz and Hatch, "Living with Multiple Paradigms"; and Peter Berger and Thomas Luckmann, *The Social Construction of Reality: A Treatise in the Sociology of Knowledge* (New York: Anchor Books, 1966).
89. Donas, "The Message of a Bottle," 412.
90. Zweibelson, "PART I: The Singleton Paradox"; and Zweibelson, "PART II: Whale Songs of Wars Not Yet Waged."
91. This does not mean the Taliban or al Qaeda subscribed to a Western war paradigm. Putting their ideological and cultural positions aside, when a Taliban cell places improvised explosive devices at a roadside ambush point, they are doing in a primitive manner what the American forces did with stealth bombers dropping laser-guided munitions on enemy safe houses.
92. Nick Bostrom, "What Is a Singleton?," *Linguistic and Philosophical Investigations* 5, no. 2 (2006); Nick Bostrom, *Superintelligence: Paths, Dangers, Strategies*, paperback (Oxford, UK: Oxford University Press, 2016); and Zweibelson, "PART I: The Singleton Paradox."
93. This is excluding a small yet growing international military design movement and the pockets of postmodern design experimentation occurring sporadically across that community.
94. Cockayne, Ruez, and Secor, "Thinking Space Differently," 195.
95. Milan Vego, "A Case Against Systemic Operational Design," *Joint Forces Quarterly*, no. 53 (2d quarter 2009): 70–75; Ofra Graicer, "Beware of the Power of the Dark Side: The Inevitable Coupling of Doctrine and Design," *Experticia Militar*, October 2017, 30–37; Eyal Weizman, *Hollow Land: Israel's Architecture of Occupation* (New York: Verso, 2007); Philippe Beaulieu-Brossard, "Encountering Nomads in Israel Defense Forces and Beyond," in *Concepts at Work: On the Linguistic Infrastructure of World Politics* (Ann Arbor: University of Michigan Press, 2020), https://doi.org/10.3998/mpub.11719182; and Philippe Beaulieu-Brossard, "Systemic Operational Design or How I Began to Worry about the Dual Use of Critical Concepts" (outline written in the course of fieldwork, University of Ottawa, Canada, 1 June 2015).
96. Cara Wrigley, Genevieve Mosely, and Michael Mosely, "Defining Military Design Thinking: An Extensive, Critical Literature Review," *She Ji: The Journal of Design, Economics, and Innovation* 7, no. 1 (Spring 2021): 104–43, https://doi.org/10.1016/j.sheji.2020.12.002; Beaulieu-Brossard, "Encountering Nomads in Israel Defense Forces and Beyond"; Philippe Beaulieu-Brossard and Philippe Dufort, "Introduction to the Conference: The Rise of Reflective Military Practitioners" (Hybrid Warfare: New Ontologies and Epistemologies in Armed Forces Canadian Forces College, University of

Ottawa and the Canadian Forces College, Toronto, Canada, 2016); Zweibelson, "The Multidisciplinary Design Movement"; and Philippe Beaulieu-Brossard, "Encountering Nomads in Israel Defense Forces and Beyond," in *Concepts at Work: On the Linguistic Infrastructure of World Politics* (Ann Arbor: University of Michigan Press, 2020).

97. English variations of his name spelling include "Kokhavi." See Yagil Henkin, "On Swarming: Success and Failure in Multidirectional Warfare, from Normandy to the Second Lebanon War," *Defence Studies* 14, no. 3 (2014): 321, https://doi.org/10.1080/14702436.2014.901663.
98. Eyal Weizman, "Lethal Theory," *Log*, no. 7 (Winter/Spring 2006): 53–77; and Weizman, "Walking through Walls: Soldiers as Architects in the Israeli/Palestinian Conflict."
99. Henkin, "On Swarming," 322.
100. For example, "centers of gravity" as assimilated into modern military methodologies bear no relationship with actual gravitational theory. The military has stripped gravitational theory of everything but a loosely associated metaphoric device (drawn from the nineteenth century writings of Clausewitz) and has repurposed "COG analysis" to mean something utterly foreign to what gravitational physicists work with. This demonstrates the dominance of a Newtonian style that incorporates terms and metaphors without altering its epistemological or ontological core positions in what warfare is and is not.
101. Cockayne, Ruez, and Secor, "Thinking Space Differently," 196.