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This paper analyzes how one might fight a future superior 'Quantum Adversary,' using Clausewitz's nonlinear ideas of war, by focusing on two parts of his trinity: chance and rational purpose. The thesis argues that quantum technology will significantly alter the characteristics of war, while the nature of war--defined as a fundamentally human endeavor--remains. Findings show that Clausewitz would focus on targeting the decision-maker and on centers of strength, as applied to a quantum adversary, through the integration of deception within both offensive and defensive strategies. Finally, findings show that the impact of quantum technologies may garner an expansion of joint warfighting, into whole-of-society approach.

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FUTURE WAR PAPER

2030: Clausewitz Fights a Quantum Adversary

**SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF OPERATIONAL STUDIES**

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DISCLAIMER

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Throughout history, technological breakthroughs have surprised societies by transforming the tools or characteristics of warfare, defying the limits of what was previously possible. Eight weeks before the Wright brothers flew at Kitty Hawk, a *New York Times* editorial criticized Samuel Langley's failed attempt at powered flight, calling it a "ridiculous fiasco" and claiming it would take a million years to achieve.[1] In the 1930s, esteemed physicists Einstein, Bohr, and Rutherford all believed that harnessing nuclear energy for practical purposes was unlikely.[2] Specific to quantum physics, Einstein could not completely understand why an atomic particle could be in two places or states simultaneously.[3] Yet, in 2015, scientists proved how this phenomenon is true.[4] Groundbreaking quantum technologies will be the next phase along the technological evolutionary spectrum, altering the characteristics of warfighting, but the nature of war—defined in military doctrine as a fundamentally human endeavor[5]—remains foundational. However, additional doctrinal claims that "no amount of technology can reduce the human dimension" of war must be revisited so future planners can contextualize military strategy and operational art and science in a quantum world.[6] Ultimately, Quantum Technology (QT) will change warfighting characteristics by challenging the decision-maker's intuition, thus altering—but not removing—the human dimension of warfighting.

Quantum technologies encompass three main areas: computing, sensing, and communications, with each already existing at various stages of maturation, and possessing the potential to have a transformative affect upon all of society.[7] Numerous countries and companies are heavily investing in this technology and while there are still engineering and hardware hurdles to overcome, the underlying theory and software is ready now.[8] Hence, challenging the maturation timelines of a novel technology misses the point. Instead, the correct question to ask, is how should military practitioners think about fighting a future quantum adversary?

Roadmap

Discussion will start with a basic primer on quantum theory and QT, focusing on quantum computing and sensors, followed by describing a notional Quantum Adversary (QA). To overcome the challenges of any futures analysis, this approach attempts to shed thinking rooted in current trends and instead adopt an enduring methodology of examination.[9] One such framework exists in Clausewitz's nonlinear conceptualization of war, manifested in his paradoxical trinity of violence, chance, and rational purpose.[10] Two parts of the trinity most applicable to QT, rationality and chance/predictability, will be analyzed from a quantum perspective. Finally, how Clausewitz might confront a Quantum Adversary is presented, with sections focusing on decision-making, centers of strength, operational art regarding offense/defense, and the potential effect of QT upon society as it relates to warfighting. Additionally, this analysis assumes America enters the next Great War *without* superior QT.

What is Quantum Theory?

Quantum Theory is the study of matter and energy based on the laws of quantum mechanics—the language of nature.[11] This quantum language is not binary or linear, and it governs the behavior of particles at the atomic level in ways that defy classical deterministic thinking.[12] Quantum theory's applicability, through QT, can deliver previously unknown knowledge via revelations of new patterns in the universe.[13] For example, mapping out the natural language of plants (photosynthesis) is inherently quantum and an area where QT might reveal surprising scientific breakthroughs.[14] Moreover, quantum theory affects life beyond the micro-world, in areas such as mechanics, linguistics, geometry, chemistry, statistics, finance, and economics.[15] The unique power of quantum theory comes from two phenomenon critical to understanding QT: *superposition* and *entanglement*. The law of superposition states that an object behaves as if it has more than one value of a measurable property, at once.[16] In other words, subatomic particles can be here or there—at the same time. However, once a quantum particle is "observed" (measured) it chooses one possibility (the location of the measurement) collapsing superposition. This means a quantum particle can be in multiple places at the same time *until* you measure it, then it "chooses" one possibility, the site of observation.[17] Theoretically, superposition combined with *entanglement* enables far greater computing speed and power than classical computers, including an entirely new suite of sensors and communications.

Entanglement results from the non-locality principle. Non-locality is similar to superposition in that it means certain particles measured in a quantum system can reveal similar characteristics of that particle across time and space because they remain connected. This connectivity—or *entanglement*—allows for a measurement of one particle to result in the same answer/measurement for the second particle, no matter the distance, because in essence they are the same particle.[18] In classical science, this is impossible; a particle can *only* exist in one spot: its observed state.[19] In quantum physics however, a particle's observed position is only an *approximate* truth.[20] For renowned physicist Michio Kahu, this is the greatest paradox in all of science.[21] For a warfighter, applicability of this technology is present in how it might shape or challenge our understanding of the current state, which is always dynamic.

Quantum Computing and Sensing

The fundamental building blocks of data have not changed in thousands of years. From the linear movement of an abacus, to flipping a transistor on/off in a modern computer, data is represented in a 1:1 ratio.[22] Quantum computing breaks those rules, with experts believing the potential affects may be more "profound than the digital computing revolution" and happen at a faster rate.[23] Due to the laws of superposition and entanglement, quantum computing can solve problems classical computers cannot and may solve other, classically solvable problems, faster.[24] An understanding of the fundamental differences in classical vs. quantum data, or bits, reveals the unique power of quantum computers.

All classical computers process data in a linear sequence of ones and zeros, with one byte storing a single number.[25] For example, two classical bits store 00, or 01, or 10, or 11 (four possible numbers, but only two-bits of information—either zero or one). However, a single quantum bit, or *qubit*, can be a zero or a one, or in a *superposition of a zero and a one*, equaling 2^n paths of classical bits.[26] Hence, two qubits can be 00, 01, 10, *and/or* 11 (four possible "states") at the same time, equivalent to 2^4 classical bits. Subsequently, three-qubits equals 2^8 classical bits and so on.[27] This all simply means that qubits provide more computing power *and* exponentially greater speed. However, how the calculations are performed are also fundamentally different from classical computers hence, they will solve problems on classical computers can solve.

While not all qubits are the same and comparisons only work per "like" qubits (there are multiple techniques in use for building qubits), an illustrative example of quantum's exponential speed is to compare a classical 300-bit chip (which can power a basic calculator) and a 300-qubit (gate model) chip. The quantum chip has the computing power of two novemvigintillion (2^{300} classical bits), which is a number that exceeds the number of known atoms in the universe, depicted in figure 1.[28] Finally, an example of why quantum computing's power is *fundamentally* different; if one were to take four cards, three of which were face up and one was face down, it would take a classical computer 2.5 calculations (on average) to find which card was face down.

A simple two-qubit computer solves this in just one calculation.[29] This 60% reduction in calculation power buys time and, if compounded over hundreds of similar probabilistic decisions, the efficiency gained is game changing. However, the key idea to remember is currently once a quantum computer takes a measurement (observation) the quantum states are depicted as either a zero or a one, similar to a classical computer. Indeed, quantum systems rely on classical computers, hence both types work together.

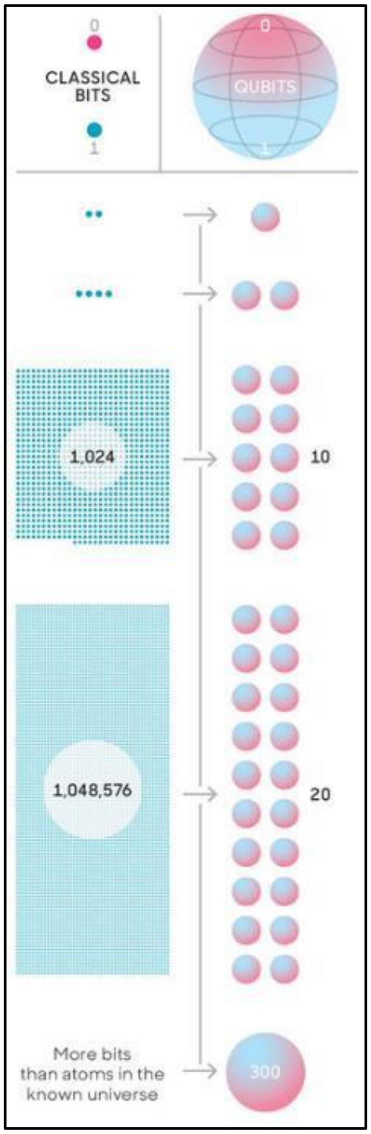

Figure 1.
Classical vs. Quantum

Qubits are producing unique computational results, leading many countries and companies to believe that this technology will enable breakthroughs in optimization, pattern recognition, and deep learning. Quantum optimization promises solutions to enormous data problems, transforming analysis in routing of traffic (e.g., missiles, aircraft, and logistics) to resolving probabilistic challenges (e.g. the card example above) much faster, in dynamic environments, and with higher fidelity than classical computers.[31] Moreover, the nexus of quantum computing's faster deep-learning and Artificial Intelligence (AI) is already providing new tools for both machine and human decision-makers.[32] Deep quantum machine learning is impossible without a general-purpose quantum computer because classical machine learning is unable to generate quantum states.[33] In fact, quantum computing may make it possible for AI to "develop something akin to intuition," by knowing what is wrong (i.e., not part of the pattern), even if the computer cannot explain why.[34] Cumulatively, quantum computers will generate and identify previously unknown patterns in the universe, making what was formerly too complex now probabilistically solvable.[35] Adding in quantum sensors will only enhance these effects.

Quantum sensors use quantum phenomena to perform a measurement of a physical quantity.[36] With quantum fidelity these new generation of sensors are sensitive enough to measure micro-changes in the Earth's gravitational field.[37] Air Force research labs expect prototypes within the next five years.[38] For example, a Interferometric Quantum sensor, which uses a coherent waveform with greater signal integrity than an electromagnetic waveform, produces superior resolution and imaging over traditional RADAR systems.[39] The application of these sensors has potential against low-observable targets (both air and sub-surface) and in a variety of other fields from medicine to biology to geology. Other applications include novel methods for navigation, timing, and detection; and these sensors will underpin other QT with amplified second-order effects throughout industry.[40]

What Does It All Mean?

Quantum technology represents a new tool in understanding the relationship between the linear and nonlinear world. While quantum mechanics can only "calculate the *probability* of the particle being in a particular place" in space and time [emphasis added], this probabilistic, or relativistic nonlinear character of quantum theory challenges our deterministic or linear understanding of the world around us.[41] The mere act of observing or measuring a quantum particle instantly breaks its superposition into a single (linear) measurement, yet the nonlinear computational solution happened in the background, where it cannot be measured. One concludes that the quantum measurement is not the whole truth, but only an approximate probabilistic truth for the measurement, in that moment in time. Therefore, the outcome is *not* that quantum technology will necessarily provide an absolute answer, but in the words of D-

Wave President Bo Ewlad, only a "*good enough* answer in a short(er) period of time" [emphasis added].[42] Most importantly, these quantum probabilistic solutions may be faster and far more accurate—for certain problems—relative to classical computer solutions.

The Future Quantum Adversary (QA)

While there is some consternation over the definition of "quantum supremacy," it is broadly defined as "quantum speed up" or a quantum computer that outperforms the best classical super computer for certain problems, optimization and pattern recognition being two examples.[43] With quantum sensors, an adversary would have additional tools to detect molecular changes in nature allowing for increased sensor fidelity against surface, above surface, and sub-surface targets.[44] More significantly, applying quantum-enabled AI (embedded within a 5G network) to the intersection of pattern recognition and decision-making, will result in an adversary with *more accurate situational awareness, speedier and greater computing power, and enhanced decision-making tools* at the operational and tactical levels of warfare. To understand what this might mean for military decision-makers, analysis now turns to a thoughtful guide: Carl Von Clausewitz.

Clausewitz and Nonlinear War

The timeless influence of Clausewitz results from his instructive framework for *how* to *think* about war. Because humans are involved, Clausewitz understood the nature of war as an unpredictable nonlinear phenomenon and consequently, any attempt to analyze, categorize, or break down war into *purely* scientific terms will be incomplete.[45] To alleviate this, Clausewitz framed his thinking around "a remarkable trinity" of violence, chance/probability, and rational purpose. Most intriguing, from the context of quantum theory, is chance/probability and how it relates to decision-making. For Clausewitz, chance makes it impossible to base decision-making on “absolute, so-called mathematical factors” because from “the very start there is an interplay of possibilities and probabilities.”[46] His famous metaphor of war as a game of cards was not to illustrate how one could predict probabilities, but to reinforce the need for a psychological understanding of the human players involved. Thus, statistical laws of probability will never fully suffice because humans, who are not always rational actors following a probabilistic formula, enter the equation. While technological advancements are helping to predict and improve probabilistic answers, for Clausewitz, any scientific solution cannot entirely remove the human element.

Unfortunately, due to Clausewitzian misunderstandings combined with the tendency of placing too much emphasis upon technological solutions, military thinkers (Westerners especially) risk limiting their thinking to linear frameworks.[47] This is partially due to human intuition, which naturally pursues linear order, but also results from the rule that, by definition, deterministic chaos cannot exist in linear systems.[48] However, as discussed, quantum technology will enable a deeper understanding of our nonlinear universe, thus challenging linear assumptions and understanding. The result may be an increase in the role of chance or, by using this novel technology, QT can offer an explanatory answer to what is previously unknown. Either way, the universe—hence war—remains nonlinear, with friction resulting from what is unknown or unexplainable and chance resulting from the human element.

To overcome chance and friction, Clausewitz called for speed, but not in physical terms. Speed is about how quickly a commander can see the “truth” (accurate recognition of the current state) and then make correct decisions—relative to an adversary.[49] However, speed in decision-making can also have drawbacks. To arrive quickly at an accurate decision, humans often rely on their intuition, or *coup d’oeil* as Clausewitz called it, which can increase the role of chance.[50]

Today, science backs up this assessment. Humans often make judgements or preliminary decisions near instantaneously, based on their intuition.[51] According to Clausewitz, to build an intuition that leads to truth, a commander must possess both *intellect* and *temperament*, which together "constitute the essence of military genius."[52] So, the question is how can a future warfighter develop *coup d'oeil* when facing a superior QA, inside a quantum battlespace that produces faster novel computational solutions and decisions options? First, Clausewitz would not sacrifice critical thinking for overreliance on models.[53] Now, heuristics such as analogies and experiences help simplify complexity, but ultimately what Clausewitz sought was critical thinking (present individually or in groups) as the avenue for finding the "truth" quickly.[54] So, the question Clausewitz might ask, does your adversary over-rely on models, or on intuition, and can that be exploited?

Clausewitz vs. a Quantum Adversary

If war ultimately remains a human endeavor and is fought across a nonlinear landscape, Clausewitz would focus on defeating the decision-maker. This could be either (or both) the human or the assumptions encoded within the quantum machine's decision-making algorithm. In essence, attack the intellect and temperament of a decision-maker to induce friction and by time, until you can counter-attack. By our definition, a QA has superior—probabilistic but more accurate—quantum solutions faster, meaning a commander's or machine's intellect and temperament may be flooded with what is calculated as "the best" or "a good enough" answers. Probabilistic quantum solutions might accurately depict the current state (decreasing unknowns and reducing friction) or could task-saturate the human mind with too many options or probabilities, increasing the role of human induced chance. Correspondingly, a decision-maker lacking quantum solutions might presumably have a less accurate (or slower) depiction of the current state, yet potentially a simpler decision-making matrix. Either way, friction is still present because accurate recognition "constitutes one of the most serious sources of friction in war" and unexpected things do happen.[55] Thus, Clausewitz would encourage injecting friction into both the computerized solutions and human decision-making—to deceive or hide the truth and elicit a suboptimal emotional response from a human, make the algorithm work against the machine, or induced ambiguity between the human and machine. However, understanding truth is only the first step.

For Clausewitz, "truth in itself is rarely sufficient to make men act," the most "powerful springs of action" lie in emotions.[56] Clausewitz might ask: If probabilistic quantum results actually portray a superior *comprehensive* nonlinear (or emotional) "truth," will the decision-maker choose to follow it? Or, would quantum solutions reduce the role of emotion in decision-making? Regardless, it boils down to how much reliance one places on computerized probabilities or accepts probabilistic solutions as "truth" for decision-making. This is the *art* of warfighting. However, increasingly art is based on scientific outputs. Why? Because, in our inherently nonlinear universe, probability (increased through QT) replaces—to an increasing degree—incomplete (or less precise) linear thinking.[57] Hence, if quantum solutions provide an edge in understanding this nonlinear world, in both speed and quality (observation and orientation), then superior decision-making increases; but *only* if the choice is made to act. Hence, one might target that choice. Luckily, there are guideposts on how others have dealt with the challenge of fighting an adversary with superior situational awareness and cognitive ability.

Clausewitz's mentor, Gerhard Scharnhorst, provides a roadmap for how to deal with chance and friction when facing a brilliant decision-maker. Scharnhorst sought to defeat Napoleon by infusing Prussian commanders with the character and intellect to make superior decisions.[58] To win against Napoleon, Scharnhorst recognized the preliminary need for comprehensive understanding of the past.[59] Additionally, familiarization with the terrain (cognitive and physical) upon which the fight will take place is paramount.[60] Finally, Scharnhorst recognized the power and role of society as a way to "bridge the gap between theory and practice" in warfighting.[61] These three premises provide a plausible framework for how Clausewitz might fight a QA.

First, military history proves the powerful relationship between deception and decision-making. Second, warfighting terrain is not just physical—it is psychological and temporal terrain—helping planners understand dynamic relationship between offensive and defensive operational choices. Finally, depending on the political and moral fabric of society, as well as the aims and capabilities of the enemy, war easily encapsulates all elements of a nation. Depending on the aims and capabilities of a QA, the future "battlespace" terrain could encompass greater portions of society, blurring the distinction between military and civilian forces and mandating an expansion in current joint warfighting concepts.

Decision-Making and Deception

The ability to make decisions within the chaos and uncertainty of war necessitates not just the deep intellectual recognition of truth, but the courage to follow that truth.[62] Where this intersects with military planning is recognizing the always-dynamic current state and there are planning tools available to help. A QA will have more. However, Clausewitz argued that to know the truth, "practice and experience dictate the answer."[63] In other words, models, rules, and principles provide only frames of reference and should serve as guides for the path to take.[64] Yet, it is also rational for the adversary to develop habitual intuition based on their experience. If one accepts the premise that intuition, based on experience and guided by reference points, is the root for judgement of truths in human decision-making, then experience becomes the target. The goal? Shape the adversary's experiences. The challenge is how to do this against a QA.

Machines, even "learning" ones, still rely on recognized patterns, models, and references points all built with gathered data. While the shaping of human behavior is delicate, it works (see the Soviet/Russian notion of reflexive control). The shaping or induction of chaos and friction into machine decision-making is perhaps harder, but in either effort, shaping actions need not be perfect to have some effect. Moreover, deception augments this process.

Effective deception is reinforcing what the adversary believes to be true. To make decisions with quantum data, adversary commanders will have to evaluate the accuracy of the current state while ascertaining which course of action is most "advantageous," a relative term—defined only in the eyes of the beholder and shaped by what is rational or logical, for them. Quantum Technology, which produces high-confidence probabilistic answers (based on assumptions programmed and data collected), might make decision-making simpler or more complicated if the assumptions are not understood, the data is flawed, or situation changes in the next instant. Moreover, as shaping actions take effect, perhaps from habitual intuition (too much reliance on quantum solutions, for example) and the error margin of the calculated solutions decreases, exploitation of what the adversary believes to be the most rational action becomes the focus. There may come a time where the most rational decision is to execute an irrational action (from the adversary's point of view) so to break the quantum pattern's assessment and induce friction and indecision in the mind of the adversary. Here, timing is critical. If done too late, or not early enough, the effect is lessened due to the superior real-time fidelity a QA will possess.

If a QA's algorithms are based on their intuition and judgement for what is rational or optimal, this potentially makes whatever that solution is counter, or perhaps inherently irrational, for the non-quantum player. Making what is perceived to be an irrational or suboptimal choice, while simultaneously taking deceptive actions to reinforce what the QA believes to be true (i.e. the rational thing), could shape the battlespace or mask the real activities taking place. This enables maneuver in time and space. Of course, the process is iterative, especially with machine learning algorithms incorporated. The counter-counter moves might be anticipated, requiring the disruption effort to expand throughout multiple domains and inevitably be layers and layers deep. This apparent paradox between what is rational and irrational lives in the cognitive domain and ties into the next element that Clausewitz would tackle: the temporal and psychological terrain of the battlefield. One technique in how to fight the cognitive terrain is in the application of offensive or defensive operational design and like QT, this is not linear.

Understanding Terrain: Offense and Defense

The decision to choose between offense or defense is a false dichotomy for Clausewitz. One can be defensive through offensive measures or vice versa because neither is a homogeneous whole. For example, one cannot think of defense without thinking about the offensive counter-attack.[65] Clausewitz assessed that defense is superior when you can inflict disproportionately more costs upon an offender.[66] Conversely, when the offender can cause disproportionately more damage to the defender, the offense becomes superior. Moreover, "damage" can take on multiple meanings, from political to psychological and lethal to non-lethal. Numerous historical examples depict an inferior party taking more physical damage (even losing multiple battles) yet win the war of the mind (e.g. Vietnam). Significantly, Clausewitz believed that an attacker cannot achieve a permanent decision with "a single, short blow."[67] The key then, is to ascertain when, where, and which form of warfare (offense or defense) is most rational against a QA. To fight a QA, Clausewitz might establish an active defensive posture enabled through limited offensive measures, focusing on targeting the superior QA's strengths. To do this, Clausewitz would study and determine the enemy's key source(s) of physical or moral strength by performing a Center of Gravity (COG) analysis.

The main strength, or COG, for a QA is the quantum-informed decision-maker, human or machine. To get that, there are hardware requirements, each with varying targetable vulnerabilities. Yet, for the decision-maker, the primary requirement is a quantum solution, and this has additional critical requirements. Specifically, to achieve a quantum solution the quantum computer or sensor requires *data*. Significantly though, mass data is outside the QA's direct control because it is simply gathered. Hence, the data becomes a critical requirement and a vulnerability or were to focus the attack.

To attack or effect data, one might flood the quantum system with rapid lethal and non-lethal actions where you want to deceive (assuming they will be seen). The goal is to shape the pattern recognition or optimized solution into a high confidence outcome, to reinforce biases and then later exploit them. Additionally, since quantum solutions offer greater fidelity, they may result in a more rapid output for analysis (with a higher degree of confidence), which is why speed is perceived to be a necessity and a strength. However, if the pace of solutions is disrupted (and this does not presuppose you must be "faster") completely different inputs still impact the enemy's temporal and psychological decision-making cycle. Throughout the execution of these techniques, the weaker side only needs to avert losing, at least initially, because time is on the inferior party's side.[68] The objective: defend to buy time until a counter-attack is possible.

Irrespective of initial damage taken in the defense, Clausewitz's goal is to survive to exploit the adversary's overextension and then, to counter-attack. The obvious assumption is the adversary overextends, but the less obvious reality is that one can shape the battlespace to drive overextension—to make it a rational choice—through shaping. The defender's actions can reinforce an aggressor's assumptions, habits, and intuition forcing an overextension scenario (by baiting or appearing weak, for example). Against a quantum adversary, Clausewitz would embed this approach into operational art, and the means to do so in a quantum environment might depend on more than military action alone and adopt a total war construct. This is because, again, data is the key requirement for a QA and all of society is part of that mass data.

Societal Impact

If raw data—pulled from all aspects of society and our nonlinear nature—is the critical vulnerability, this reinforces the principle that war remains a human endeavor (since humans are sources of data), but also, reveals a premise that warfare against a QA encapsulates more than military-to-military conflict. This could result in two potential concerns. First, which type of society is more suited to quantum thinking (via data manipulation)? Second, what would (or should) be the corresponding societal response to a QA's attack?

There are profound cognitive differences between societies with contextual ramifications for how each understands warfighting. As analyzed, Westerners generally adopt a deterministic view of the world, focusing on linear aims and fundamental principles as opposed to the larger nonlinear picture. This is due in part to Western philosophical dominance over the past 500 years, and especially in the post-World War II international order that resulted in a rules-based system governing the behavior of nations.[69] This cultural bias often manifests militarily in the desire for a simplistic linear problem-solving method. However, in contrast, for Eastern political decision-makers, the context of an argument is often more important than the structure: "I think the world is a circle, you think it's a line."[70] Moreover, Eastern minds often have no problem holding two opposing ideas in an accepted balance (nonlinearity). Historically, when this

East/West cultural contrast manifests in conflict, Western societies have struggled to understand the nature of the adversary—hence the war (e.g. Korea and Vietnam). In contrast, when a Western opponent fights an adversary that closely resembles our way of thinking (e.g. Germany), we are more successful.[71] If Eastern societies are more naturally comfortable with quantum thinking (due to its nonlinear nature), this may amplify an Eastern QA's affect, from a societal perspective. Alternatively, QT may nullify, to an unknown degree, certain cultural dichotomies. This would apply most from a purely scientific perspective (facts are facts), however when the science is applied to the art of warfighting, then cultural variables reemerge.

Consequently, fighting an Eastern QA may demand an expanded view of Joint Operations—even beyond the "whole of government" ideas of today. Grounded in Clausewitz (and in history) is the notion that any war could easily become a total war effort. Scharnhorst recognized that a country's military might is intimately linked to the *character and intellect* of the nation.[72] The difference in the future is quantum warfighting may necessitate entire societal participation in the "fight" beyond the massive civilian participation in economic production—as witnessed in both World Wars. A total war manifests itself most directly in terms of mass data collection and manipulation, which is ongoing today. Society has a role in that. In a quantum war, joint warfighting may necessitate further integration to expand throughout government and beyond to private-public-government-military partnerships at all levels of war. The society that does this best, wins.

CONCLUSION

This analysis affirmed that QT is fundamentally different than any other computational process, which will result in a paradigm shift when it comes to computational problem solving and understanding of our naturally nonlinear world. However, against a QA, humans are the primary sources of data and are the strategic decision-makers. Hence, the thesis reexamined remains partially true. For Clausewitz, the character of a time period can influence the ends and methods in war, *without* changing its nature[73] Current Marine Corps (and Joint) warfighting doctrine reinforces this premise: “We have concluded that war is a human enterprise and *no amount of technology can reduce the human dimension* [emphasis added].”[74] Yet, one must recognize that superior technology can alter—often decisively—the characteristics of warfighting, and this analysis shows that QT may be decisive. Therefore, the above claim that “no amount of technology can reduce the human dimension” is incomplete and current doctrine may need re-examination from a QT perspective, especially at the tactical and operational levels of war.

However, despite QT’s potential, the nature of future warfare will remain a human endeavor. While the tools used to make decisions might be new, Clausewitz would fight a superior QA by targeting the intuition of the human (or machine) decision-maker through the manipulation of mass data, in order to remain unpredictable. The COG analysis findings reinforce the need to dominate the cognitive terrain. Consequently, the last key result of this analysis is the degree and/or type of human activity or participation (the data) in a quantum war may incorporate a greater element of society as a whole, and, in new ways.

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