Sgt. Kyle McAuley (*right*), Legion Troop, 1st Battalion, 503rd Infantry Regiment (Airborne), 173rd Infantry Brigade Combat Team (Airborne), directs Spc. Antonio Carroll, Attack Troop, 1st Battalion, 503rd Infantry Regiment (Airborne), 173rd Infantry Brigade Combat Team (Airborne), as Carroll prepares to fire an FIM-92 Stinger during a training exercise 25 April 2018 at Hohenfels, Germany. The Joint Warfighting Assessment helps the Army evaluate emerging concepts, integrate new technologies, and promote interoperability within the Army and with other services, U.S. allies, and partners. (Photo by Staff Sgt. Kalie Frantz, U.S. Army)

# Warfighting

## A Function of Combat Power

Maj. Thomas R. Ryan Jr., U.S. Army

It is military dogma that the nature of war will never change, only how we perform its fatal rituals.[1] The domains in which these acts manifest have remained defined and understood throughout history—land, sea, air—with a few added more recently—space and cyberspace.[2] For the U.S. Army, understanding how to synchronize across domains is not a new pursuit. Over time, the phrasing transformed from dimensions to cross-domain, to what it is now multi-domain.[3] As we begin to understand the

multi-domain framework, research already presents how challenging it will be.

In a 2019 report titled *European Allies in U.S. Multi-Domain Operations*, authors Jack Watling and Daniel Roper open with, "Russian and Chinese long-range fires, combined with non-lethal standoff able to shape the operational environment prior to conflict, have led the US Army to conclude that AirLand Battle—the underlying doctrine for its operations—has been 'fractured.'"[4] It will take a new way of thinking to break into our competition's antiaccess and area denial should conflict ensue. The new cognitive framework the U.S. Army is pursuing is multi-domain operations (MDO), and it requires convergence of combat power at a specific instance in time and space.[5] The traditional ways in which we organize warfighting are not as clear as they used to be.

The central idea for the U.S. Army's MDO is to "penetrate and dis-integrate enemy anti-access and area denial systems and exploit the resultant freedom of maneuver to achieve strategic objectives (win)."[6] To achieve this, the U.S. Army will leverage a "calibrated force posture, multi-domain formations, and convergence."[7] Convergence is defined as "rapid and continuous integration of capabilities in all domains, the EMS [electromagnetic spectrum], and information environment that optimizes effects to overmatch the enemy through cross-domain synergy and multiple forms of attack all enabled by mission command and disciplined initiative."[8] The only way to fully implement this strategy is to ensure it is properly accounted for during the planning process at echelon.

Traditionally, U.S. Army commanders and their staffs organize planning using a framework called combat power, with a subset of those elements called the warfighting functions. Army Doctrine Publication (ADP) 3-0, *Operations*, states, "The purpose of warfighting functions is to provide an intellectual organization for common critical capabilities available to commanders and staffs at all echelons and levels of warfare."[9] Based on the ever-changing domains and understanding of how we organize for combat, the U.S. Army's elements of combat power may be "cul-de-sacs leading to a dead end" of understanding.[10] We are anchored to fitting all aspects of warfare into those categories.[11] To expose our bias and explore new opportunities, a different way of thinking is required.

Systems thinking is built on the premise that all cognition follows the rules of distinction, system, relationship, and perspective, which helps us navigate those categories with a newfound understanding.[12] The use of these rules enables self or organizational awareness toward the logic used to construct current models. Applied systems thinking yields stronger mental models or can help reframe old ones. To acknowledge the influence of Baron de Jomini on the U.S. military thinking and whose principles of war can be "almost mathematical," one such mental model is the mathematic equation and how each variable can represent a systems of equations, and the parameters that make them up—in this case the elements of combat power.[13]

The aim of this article is to achieve two outcomes: first, to demonstrate how mathematical modeling is a unique way to visualize old relationships leading to novel insights and deeper understanding; and second, to propose to senior leaders in the Department of Defense (specifically, the Army) that the way we think may be anchoring us toward an incomplete understanding of the future.[14] Hopefully these outcomes will generate discussion among senior leaders in the Department of Defense that our framework might be in need of new thinking, even if math is an obstacle.

## The Formal Representation of the Elements of Combat Power

ADP 3-0 explains combat power (the left side of the equation in figure 1, page 63): "To execute combined arms operations, commanders conceptualize capabilities," and "[when achieved, it] is the total means of destructive, constructive, and information capabilities that a military unit or formation can apply at a given time."[15] The six warfighting functions are a subset of

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$$f(\text{Combat Power}) = \left( \frac{\text{Intelligence} \times (\text{Fires} + \text{Maneuver} + \text{Protection} + \text{Sustainment})}{\text{Command \& Control}} \right)^{\text{Information}}$$

(Figure by author)

**Figure 1. A Mathematical Representation of the Elements of Combat Power**

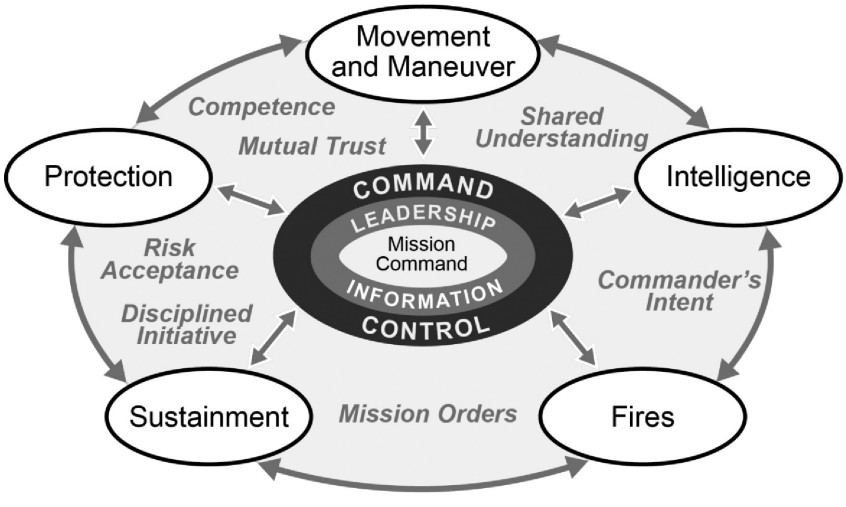
the elements of combat power applied in the physical domain of warfare.[16] Again, these elements are used to ensure plans are exhaustive. Staffs organize in these groupings to plan, and commanders provide guidance along these lines to ensure that they are utilizing every available resource to facilitate mission accomplishment.

We are fascinated using the word "function" and what unique perspectives, possibly insights, it could bring forth by modeling the elements of combat power. Throughout one's Army career, these types of lists are presented in doctrine as time-tested truisms that need to be remembered, studied, and respected because they are relevant even as the face of war changes, because its nature remains relevant.[17] Professor George Box is attributed to saying, "All models are wrong, but some are useful," and his work depicted in figure 1 is one way of representing the relationships between the elements of military combat power.

When teaching undergraduate engineering students to build mathematical models, Murray Teitell and William S. Sullivan conclude, "By finding the simple relationships and laws that govern systems, it leads to innovations, new concepts, and better [understanding]."[18] This portion of the article, in pursuit of those results, will first explain the elements of combat power using U.S. Army doctrine, describe the elements as parameters to define the mathematical system of combat, and highlight some of the insights gained from the model. The next section will present the doctrinal framework of combat power and how it is implemented when preparing for an operation or battle.

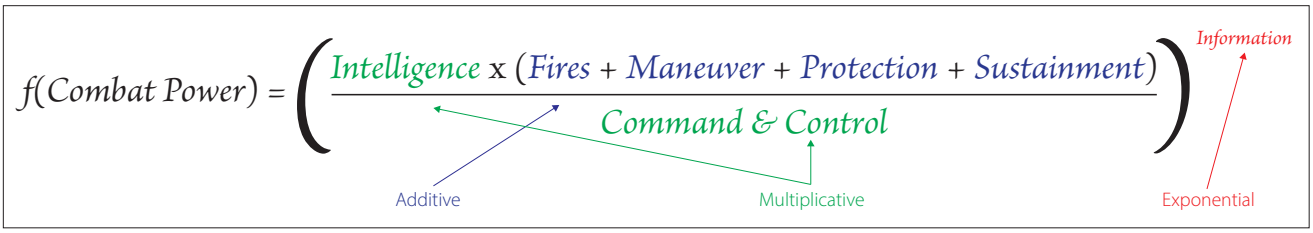
The Army teaches its leaders to think and structure its solutions in a framework that leverages all available combat power. Commanders at every level in the U.S. Army go through a deliberate process to prepare for conflict—it is a mixture of art and science. All levels of command must consider the elements of combat power; however, organizations that have a staff start to align along these elements to help the commander understand, visualize, direct, and decide.

Those elements, depicted in figure 2, are leadership, information, command and control, movement and maneuver, intelligence, fires, sustainment, and protection.[19] The subset of elements known as the warfighting functions are the last six elements listed. Unique to the warfighting functions, compared to the other two elements—leadership and information—is that they are "physical means that tactical commanders use to execute operations and accomplish missions assigned by superior tactical- and operational-level commanders."[20]




(Figure courtesy of Army Doctrine Publication 3-0, *Operations* [2019])

**Figure 2. A Visual Systems Diagram of the Elements of Combat Power**




(Figure by author)

**Figure 3. A Mathematical Representation of the Elements of Combat Power and the Super Relationships of Additive, Multiplicative, and Exponential Parameters**

Through the military decision-making process, staffs apply the elements of combat power to deliver mission orders—written documents with visual depictions—that act as a set of instructions to achieve victory, similar to a coach's playbook for any sport.[21] Although over time, the number of elements listed in the U.S. Army's combat power framework has expanded and contracted, the way in which they are presented—in diagrams and word format—remains constant.[22] By modeling the elements of combat power mathematically, the next section will attempt to present a nontraditional perspective, not changing any of their properties, to gain unique insight to how they relate.

## Building an Equation

Before showing how each ingredient in this article's mathematical model, or parameters, is defined for combat power, we will first show how math models in general can be organized into some main parameters: additive, multiplicative, and exponential.[23] In figure 3, these parameters interact with each other and the rationale is included that helps explain their role in the overall equation.[24]

According to Barry Boehm and Ricardo Valerdi, a parameter "is additive if it has local effect on the included entity."[25] Additive elements will "measure the functional size of a system."[26] "A factor is multiplicative if it has a global effect across the overall system."[27] If the impact of the size parameter can be doubled, or fractioned, based on the effect of a given parameter, then that parameter is multiplicative.[28] A factor is exponential if it has both a global effect across the system, and an emergent effect for larger systems.[29] If the effect of a given parameter is influential as a function of size because of its impact to maneuver, fires, protection, or sustainment, then it is treated exponentially.

## Building the Equation, or the Function (Elements of Combat Power)

To leverage the elements of combat power in a mathematical equation, we must first establish them as parameters that represent the system of warfare. A parameter is defined as "a numerical or other measurable factor forming one of a set that defines a system or sets the conditions of its operation."[30] Parameters are typically leveraged in a system of equations attempting to reduce the complexity of any individual input, or in this case element of combat power, so collectively, the process is better understood and is therefore more applicable.[31] For this article, we will refine the elements of combat power as such and present them sequentially—the output, additive, multiplicative, and exponential.

## The Output: Combat Power

The output, combat power, is the left side of the equation. It is the result, or output, of the relationships described below. In concert with how the U.S. Army currently leverages this framework, its result is a holistic consideration of how these elements contribute to mission accomplishment. The aim here is to provide a different perspective, and potentially new insights that will be discussed in a later section.

## The Size Factor: Maneuver, Fires, Protection, and Sustainment

These parameters are where scale, size, and scope of an operation generates. What echelon—brigade,

$$f(\text{Combat Power}) = (\textit{Maneuver} + \textit{Fires} + \textit{Protection} + \textit{Sustainment})$$

(Figure by author)

**Figure 4. The "Physical Elements" Drive the Size and Scope of a Combat Operation**

division, corps, army—is the decisive operation? Does it create overmatch with the enemy? The physical elements of combat power—movement and maneuver, fires, protection, and sustainment—are the basis of our understanding of warfare. In this essay, they are described as the physical elements because unlike every other element, these four elements must exist in the physical domain (see figure 4). The physical elements are the most understood, and we can use other models to derive their value if required.[32] Without them, we do not win, but they do not have to be perfect—they must merely be good enough. The analogy is a layup in a basketball game; if the ball goes in, does it matter how ugly the shot really was?

The fact is maneuver and fire are the core of physical combat, and our military trains cognitively and physically to dominate with these factors. Our sustainment enterprise is world class, as demonstrated by our ability to send the immediate response force and its complement of capabilities at home and abroad for no-notice missions multiple times in two years. Finally, our protection capabilities can leverage joint power to respond to any threat. This in no way diminishes their contribution to warfighting. The next section will discuss some of the insights gained by mathematically modeling the doctrine of warfighting.

## The Multiplicative Factors: Intelligence and Command and Control

Both intelligence and command and control (C2) impact the system globally, which in simpler terms means that the rest of the organization relies on them to succeed. In this model, we will first discuss intelligence. Then we will focus on C2, present the "law of relative variety" to explain why C2 is used as a "control" to the system, as well as discuss how leadership is most present in the command aspect of this element.

"Information is of greatest value when it contributes to the commander's decision-making process," and therefore without it, the perfect plan is no more than a commander's educated guess on a way to accomplish the mission.[33] Intelligence drives operations and turns planning assumptions into planning facts. To differentiate from the information parameter, the intelligence parameter deals with acquiring priority information requirements about the enemy, friendly forces, and the environment. Therefore, intelligence impacts the system globally, communicating that as this element of combat power goes, so do the rest.

As demonstrated in figure 5, we assume we are unable to gain any intelligence. A theoretical "0" communicates no factual understanding of the situation, and all assumptions, resulting in no intelligence, enable suitable planning. Commanders and staffs can use assumptions, as previously mentioned, to create a rational and logical action; however, this will nullify the physical elements of combat power.

A way to leverage what is known in the intelligence community is predictive analysis.[34] Predictive analysis is not new; however, in the age of MDO, leveraging high performance computing with autonomous programs and artificial intelligence to analyze robust amounts of data is.[35] These new practices are already used in the civilian sector by large entities like Google, Meta (formerly known as Facebook), and Amazon.[36] With the license to practice predictive analysis, one can assume that as the "size driver," intelligence will never actually be "0." If intelligence will always be greater than or less

$$f(\text{Combat Power}) = \textit{Intelligence} \times (\textit{Physical Elements})$$

(Figure by author)

**Figure 5. Intelligence as a Multiplicative Parameter**

$$f(\text{Combat Power}) = \frac{\text{Intelligence x (Physical Elements)}}{\text{Command \& Control}}$$

(Figure by author)

**Figure 6. Command and Control as a Multiplicative Parameter**

than "0," the grouping of physical elements of combat power (fires, movement and maneuver, protection, and sustainment) will always yield some measurable impact—positive if the intelligence is correct, and negative if the intelligence is unknowingly incorrect (e.g., the enemy was able to distort our reality).

Before we move to the second multiplicative element of combat power, C2, we will introduce the law of relative variety, which in its simplest form states that the complexity of a system also establishes the complexity of any controls for that system.[37] Another way to understand this is to think of a bicycle and an airplane as two systems. The controls on a bike match the simplicity of a bike while the cockpit of an airplane is as complex as the type of aircraft used.[38] Viewing C2 through this lens will help explain why we place it under the impact of intelligence toward the physical elements. Next, we will describe why this model aligns leadership toward the "command" portion of C2.

C2 consists of two super variables, command then control. For the purposes of this model, command will also represent the element of leadership as commanders are the leaders of their units. Leadership is very important and can motivate or detract from the morale of a unit.

However, in the case of this model, leadership is an aspect of command. The commander must have the presence, character, and communication to ensure that orders, intent, and purpose saturate and empower their units. Additionally, command will include the U.S. Army's concept of mission command, or the "art" of building the optimal culture for the science of command.

Finally, command will also include the expanded purpose and intent, two separate paragraphs of the operations order that the commander is supposed to write that simplify and articulate what matters. The simpler the better. In this model, leadership will become a component of the C2 parameter.

With respect to control, this variable will represent any human limitation or constraint required to control the operation. An example of these controls could be graphical control measures, symbols and lines typically overlayed on a map to contextually regulate units and capabilities. Other aspects of control are the communications and information systems. The way in which units communicate and share information is wildly complex. Therefore, if a particular operation or battle requires less systems to succeed or the interoperability of the required systems overlap, it is logically better.

The C2 parameter is placed in the denominator because if leveraged under normal conditions, it equals "1," preserving the potential of the other elements (see figure 6). A command-and-control value less than 1 could represent the power of a phenomenal personality or the synergy of a realized interoperability control system that maximizing the kill chain, therefore enhancing the potential of physical elements.[39] If the commander is unclear, the plan too complex, or the number of systems required to operate too robust, then the value of C2 grows larger than "1." If the value of C2 is larger than "1," then full capacity of the other elements is diminished. This is the power of command and control; one must find the comfort to be in command and out of control.[40] Finally, in the essence of John Boyd's "Destruction and Creation" wherein he leverages the second law of thermodynamics and entropy to present that an overcontrolled and closed system will ultimately lead to chaos and die—so becomes the impact of C2 globally as it attempts to synchronize the elements of combat power toward mission success.[41]

## The Exponential Factor: Information

The multiplicity in this domain makes the information parameter powerful and is why we suggest making it an exponential parameter. It not only affects the current military system but is also a link to the political and societal systems we operate. Information has water-like properties and can simultaneously exist in multiple states, at multiple levels of warfare, while

$$f(\text{Combat Power}) = (\text{Warfighting Function})^{\text{Information}}$$

(Figure by author)

**Figure 7. Information as an Exponential Parameter**

concurrently impacting all other elements.[42] To communicate this effect in the mathematical model, it will be used as an exponent for the aggregation of the other elements of combat power—labeled the warfighting functions. The highest level of information exists as an instrument of national power, and in its lowest state, information can be demonstrated by the interaction between a private and their operational environment.[43] Information is also an effect that can be shaped, manufactured, and pre-positioned through the targeting process—deliberate and dynamic themes and messages.

Although the intelligence parameter, discussed earlier, focuses on the process of collecting data and using it to plan, the "information" parameter is how the rest of the world perceives data and therefore how we are able to leverage that activity. NATO seems to understand this already, as it has added more nuance to its combat functions to include an information activity's function.[44]

The information parameter exponentially intensifies the other elements of combat power or neutralizes/minimizes any success they may have (see figure 7). Therefore, it will nominally be set to 1, but if we are able to leverage the power of this parameter it can quickly benefit our forces. Perception is reality, and perception is represented by the information domain. An example is the strategic corporal, as discussed by Maj. Lynda Liddy, who claims the way in which we conduct war may have more external impact than the results of the war we conducted.[45]

Additionally, our current "near-peer" competition affords more latitude in this space for its lower echelons, as well as taking more risk by sponsoring full-fledged disinformation campaigns toward our forces. This is not commentary on our use of the information parameter, but another way to highlight the power it has toward the other elements of combat power, especially as they are leveraged against us.

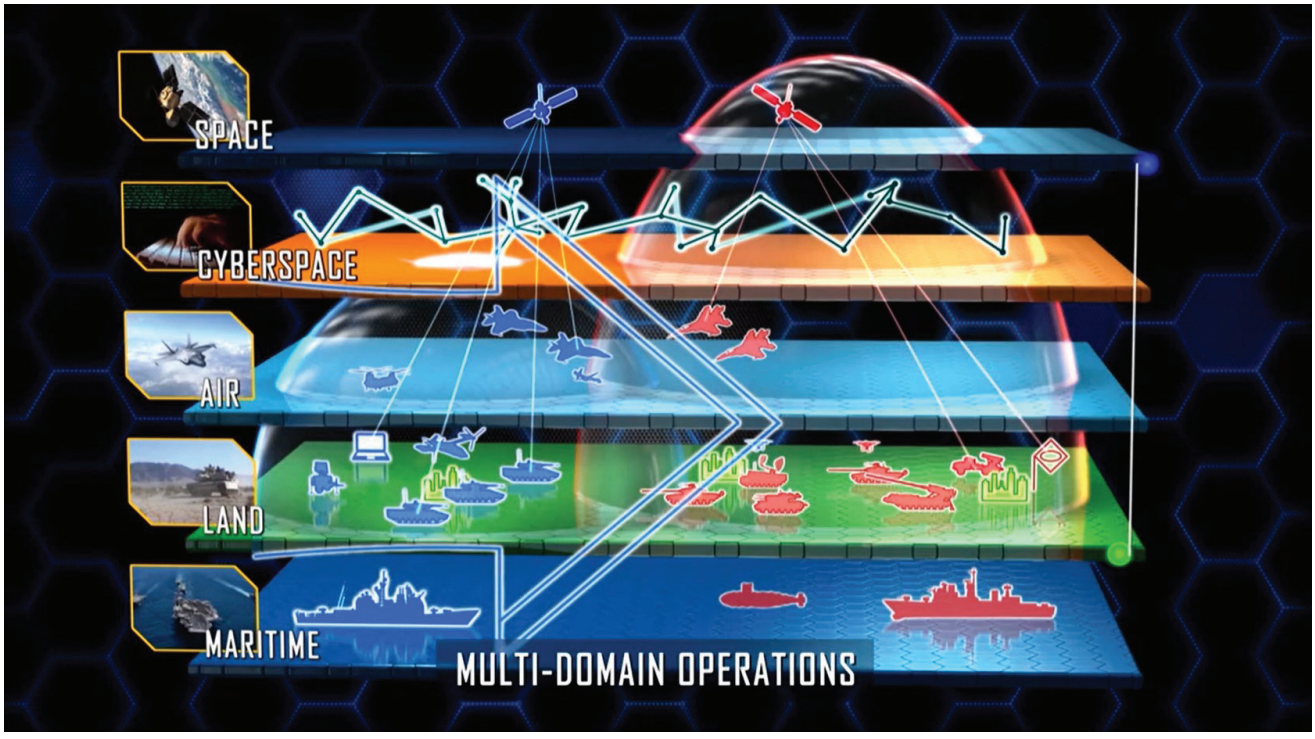
## Insights Gained

The exercise of mathematically modeling the U.S. Army elements of combat power has led to many ideas, implications, and opportunities for future considerations. This article will focus on only a few of them, such as its implications toward the MDO framework, the power of the element of information—another recommendation to formally make it a warfighting function for the U.S. Army, and how new models challenge existing perspectives. As the U.S. military pursues MDO, the U.S. Army also seeks better understanding.

## Multi-Domain Operations

Using a mathematical model to communicate specific relationships between the elements of combat power directly links to the third tenant of MDO, convergence. Convergence is "the rapid and continuous integration of capabilities in all domains, the EMS, and the information environment that optimizes effects to overmatch the enemy through cross-domain synergy and multiple forms of attack all enabled by mission command and disciplined initiative."[46] U.S. Army Training and Doctrine Command Pamphlet 525-3-1, *The U.S. Army in Multi-Domain Operations 2028*, mentions variations of "optimization" and "synergy" thirteen and twenty-three times respectively.[47] These terms communicate a mathematical basis. To optimize is to use calculus to find the maximal value or minimal value of the given information.[48] To achieve synergy is to understand that the total sum of the parts, or complete system, is of greater value than the components, or 1 + 1 = 3.[49]

What is more important is how we will leverage distinct relationships between the elements. In the MDO environment, our nonhuman teammates are artificial intelligence, unmanned systems, and autonomous systems—they speak in "ones" and "zeros." To translate our commanders' intent to our partners, we will have to communicate through code our elements of combat power sooner rather than later. Using a model like the one proposed in figure 1 generates a more comprehensive understanding toward how a commander may want to harness his or her elements of combat power in each situation. These insights will prove paramount when the commander must insert his or her professional military




(Screenshot from *U.S. Army in Multi-Domain Operations 2028* by William Norris, U.S. Army Training Support Command)

judgment because the systems are not making sense due to maligned influence from a bad actor or a staff officer incorrectly implementing a tool.

The information environment seems to be a critical area of emphasis in MDO as it is mentioned seventy times.[50] Again, the use of our nonhuman teammates is mentioned by Gen. James McConville: "The Army also leverages an array of capabilities to operate in the information space and ensure that the nation can consistently win with the truth."[51] Additionally, McConville frames our transition to MDO in these terms:

> The United States Army faces an inflection point that requires innovation, creativity, and entrepreneurship in the application of combat power. Our Nation's adversaries have gained on the Joint Force's qualitative and quantitative advantages. If the Army does not change, it risks losing deterrence and preservation of the Nation's most sacred interests.[52]

It is under these terms that this article transitions to the discussion of information and adds to the decades old plea to include it in the coveted warfighting functions.[53]

## Information

The definitions and concepts of doctrine are not as quick to adapt as our adversaries are to find new ways to apply new technologies across multiple domains. The element of information, defined by U.S. Army doctrine, attempts to force three distinct subsets into one: knowledge management, information management, and information themes and messages. After modeling information as a parameter, it seems that the first two are more aligned with the "control" aspect in the C2 function.

The information themes and messages are more aligned with a fires function of effects. It is distinct from fires; however, the targeting process should be leveraged. Additionally, the collateral damage of "information as a weapon" is unlike any other effect as one attempts to modify how people think and feel in a deliberate manner. In the fires function, we have nuclear warheads and cybermunitions that yield high collateral damage; however, they do not attempt to take one's beliefs and modify them for state actions. Therefore, the model places information in an exponential modifier to the physical functions.

There must be a more accurate definition for the element of information so it is not as confusing. Consider relabeling it as the virtual, information

operations, information warfare, or adopt NATO's information activities.[54] The virtual concept was explored by Col. (Ret.) Stefan J. Banach in his discussion with the U.S. Military Academy's Modern War Institute, "Virtual War: Weapons of Mass Deception."[55] The information operations is also of concern to Australia's Maj. Gen. Marcus Thompson, as he presented on the topic in 2018.[56] The implication is that our near-peer competition currently leverages this element with more audacity and in a deliberate manner. This is due to our moral understanding surrounding the implications of misusing this capability and the risk that they are willing to assume. This is demonstrated with the levels authorized to act with autonomy in this element of combat power.

Irrespective of what the U.S. Army labels planning for the effects of "information," the information environment, like the other warfighting functions, needs to be deliberately and distinctly considered in planning. As stated by a U.S. Marine Corps officer, "The placement of information on a higher plane in the hierarchy of warfare will require a paradigm shift in how the U.S. plans, prepares, and conducts war."[57] This paradigm shift is required to properly prepare for the current operating environment, as Russian forces plan to stage a fake attack to justify their aims, and for the supposed information environment of 2040.[58] Again, the purpose of the warfighting functions is to ensure that commanders and staffs integrate and synchronize their combat power to accomplish the missions assigned.

## Perspective—The Power of Seeing the Something Familiar in a Unique Way

Here are some reasons why thought experiments like this can lead to deeper understanding, even if math is an obstacle. Wicked problems arise when there is a mismatch between people's mental models.[59] The U.S. Army does a lot to alleviate this in its orders process by requiring a written version, pictures that also communicate the plan (concept sketches and terrain models), a briefing, and some level of rehearsal. These deliverables, or products, also align with the educational acronym VARK, or visual (sketches and terrain models), audible (the briefing), reading (the written order), and kinesthetic (the rehearsals).[60]

When building or interacting with a mathematical model, the audience expands to a different form of language, a different perspective. Math is called the universal language for a reason, and even those who are not mathematically inclined can still get stimulus from having a conversation about the relationships between the parameters. For instance, when presenting this model to my NATO colleagues, a wise Dutch lieutenant colonel quipped, "I do not remember math like this; but it is clear that placing the functions in this way will generate new ways of thinking."

The point is, just sharing this idea with other staff officers sparked a few hours of discourse and deeper understanding of how the elements relate. Imagine what other aspects of military dogma could be explored if we were to model them mathematically, or in other ways not traditionally used.

## Conclusion

Modeling anything with a math equation communicates a very quantitative discussion that invokes the anti-McNamara crowd to gain a louder voice than necessary, "because of [McNamara's] role in [quantifying outcomes during the Vietnam War], he tends to be caricatured as smart but not wise, obsessed with narrow quantitative measures but lacking in human understanding."[61] However, this is an oversimplified stereotype of numerical analysis. Numbers only tell half the story, and that is why the Army's Functional Area 49 is both operations research and systems analysis. The systems analysis should add the qualitative synthesis to any numerical estimate—see Mr. Box's quote at the beginning. The fact is this bias is real and could be a true detractor to any further attempts to mathematically model such a complex set of parameters like the U.S. Army's elements of combat power. Even as the battlefields become a stark comparison from the days of Antoine-Henri Jomini and Carl von Clausewitz, our quest to leverage their insights remain steadfast: "The Army will leverage emerging capabilities and forward posture to expand the battle space by maneuvering in areas 'inside' and 'outside' the traditional theater geometry."[62]

This article is not about making a new relative combat power number generator (i.e., correlation of forces calculator) or suggesting that we can reduce warfare to

a simple formula. It simply recommends "information" be moved into the coveted category of warfighting function to enable the tenets of MDO (calibrated force posture, multi-domain formations, and convergence), and it demonstrates how visualizing a mathematical relationship between the elements of combat power could help facilitate implementation into our future partners—artificial intelligence, unmanned systems, and autonomous systems. We as a profession need to embrace different perspectives of historical truths—especially if we want to remain on the cutting edge of competition deterring conflict. ■

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