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SCIENCE VS. the Art of War

Germans confront Serbs in World War I (drawing by Richard Caton Woodville)

By MILAN VEGO

War is an art and as such is not susceptible of explanation by fixed formula.

—GENERAL GEORGE S. PATTON

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People generally do not feel comfortable with uncertainty. Hence, there is a constant search in life—including in the military—for deriving various principles or rule sets and making things more controllable and predictable. Since ancient times, militaries have been engaged in an endless quest for certainty in the command in war.[1] They have striven to precisely know all the key elements of the situation including the enemy force and its intentions and reactions to their own actions.

Warfare as a Science

The idea that the conduct of war is a science is almost as old as warfare itself. In ancient times, military theorists started to search for certain principles and rules guiding the conduct of war. During the Renaissance, art, music, philosophy, government, science, and warfare underwent a gradual but profound transformation.[2] In that era, Europeans rediscovered the military treatises written by ancient military theorists, specifically Xenophon (430–354 BCE), Julius Caesar (100–44 BCE), and Publius Flavius Vegetius Renatus (4th century CE). The classical legacy formed the intellectual background

and source of historical reference for military thinking until the end of the 18th century.[3]

The scientific revolution in the late 17th and 18th centuries was the result of new ideas and advances in physics, chemistry, astronomy, biology, and medicine. Because of great thinkers such as Isaac Newton (1643–1727), scientific discourse took the preeminent role in reordering society within Western civilization. There was a closer association with technology.[4] The first techno-scientific revolution in European warfare was articulated around a clockwork metaphor, which became the symbol of order, regularity, and predictability. The clock concept was emulated by European militaries as exemplified by Frederick the Great (1712–1786).[5]

Moreover, bombardments and fortifications became increasingly guided by geometrical principles and the great advances in ballistics. The most influential practitioner of siegecraft was the French Marshal Sébastien Le Prestre de Vauban (1633–1707). He used his understanding of geometry, architecture, and gunnery to advance the science of fortifications.[6] In his 30 years of professional activity, Vauban personally designed a number of fortresses and conducted nearly 50 sieges—all of them successful.[7]

The Italian-born Austrian field marshal Raimondo Montecúccoli (1609–1680) was one of the most influential practitioners and theorists in the late 17th century. He was one of the first who tried to explain warfare "scientifically."[8] Montecúccoli observed that like all sciences, the science of war aims to reduce experiences to universal and fundamental rules.

The French marshal Jacques-Francois de Chastenet, Marquis of Puységur (1656–1743), was a distinguished soldier who undertook a systematic treatment of war. He believed that experience was not the only approach to understanding war. Puységur's intent was to reduce warfare to a set of rules and principles, as had already been done for sieges.[9] Like Montecúccoli, he observed that war was the most important of all sciences and arts. He further claimed that war during his life lacked a systematic theoretical study, with people relying on tradition and personal experiences. In his view, field warfare needed to be made as scientific as siegecraft had been by Vauban. Hence, the emphasis should be on the study of geometry and geography and their applications to the art of war.[10]

The writings of French military theorist and soldier Jean-Charles de Folard (1669–1752) were the main precursors of "enlightened military thought." Folard was fascinated with classical Greece and Rome. He examined war from a scientific perspective in order to discover universal principles guiding its conduct. He also addressed psychological dimensions in combat. His writings influenced many military theorists and practitioners of the Enlightenment era, such as Maurice de Saxe, Frederick the Great, and Napoleon Bonaparte I (1769–1821).[11] Saxe (1696–1750) was one of the most successful generals of the era of musketry. He wrote the famous *Reveries on the Art of War* (1757). In the preface, he stated that "war is a science so obscure and imperfect that custom and prejudice confirmed by ignorance are its sole foundation and support; all other sciences are established upon fixed principles . . . while this alone remains destitute."[12] To understand war, Saxe argued that without knowledge of the human heart, one is dependent on the favor of fortune, which sometime is inconsistent.[13]

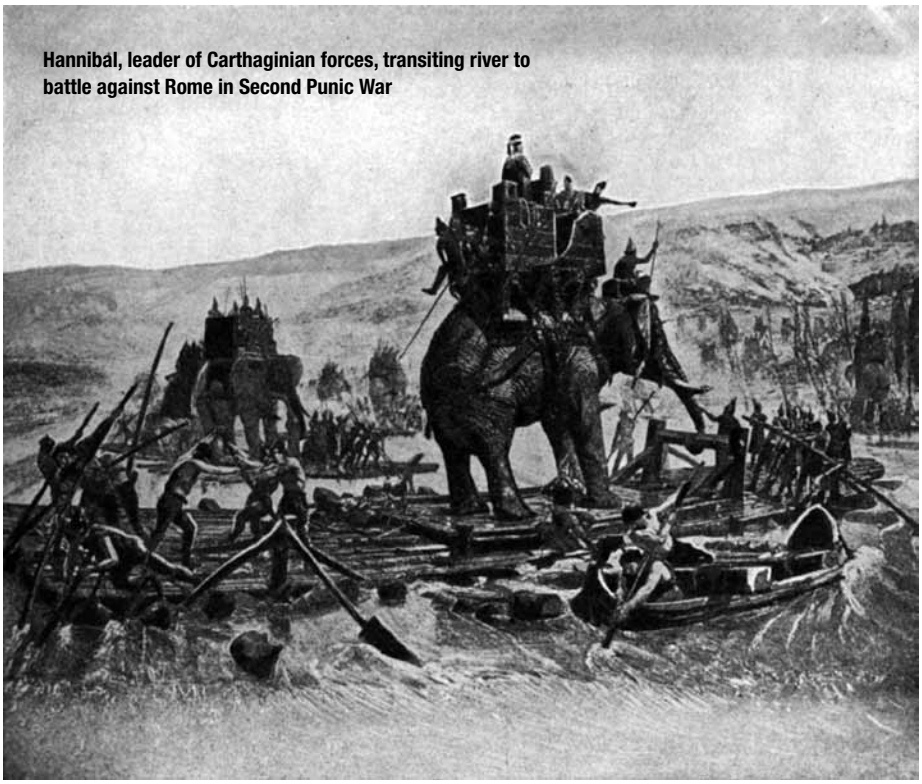
The Enlightenment Era, 1750–1800

The scientific revolution of the 17th century, and the beginning of Newtonian science in particular, led to widespread belief among European intellectuals that the human mind is capable of mastering all realities. Another influence during the Enlightenment was French neoclassicism, which taught that each art is governed by certain universal and immutable principles and rules.[14]

Military officers, mostly from the ranks of nobility, became influenced by the philosophical, intellectual, and cultural trends of the late 18th century. They concluded that war, like other sciences, has to be studied systematically, and then a clear and universal theory of war could be created. Hence, the military profession must be studied theoretically and not only by using combat experiences. This new emphasis on the study of war resulted in a significant increase of published works dealing with military theory.

Dominant ideas in military thought during the Enlightenment were rudiments of appreciation of the political side of war, especially in Prussia under Frederick the Great (1712–1786); the realization of the role of psychological factors in combat; and the unprecedented application of pseudoscientific principles to the study of warfare.[15] The most important military theorists of the Enlightenment were Count Turpin de Crissé (1709–1799), Paul Gideon Joly de Maizeroy (1719–1780), Frederick the Great, Pierre-Joseph de Bourcet (1700–1780), Jacques Antoine Hippolyte, Comte de Guibert (1743–1790), Henry E. Lloyd (1720–1783), and Dietrich Heinrich Freiherr von Bülow (1757–1807).

In the late Enlightenment era, military theory was dominated by the advocates of the so-called geometrical or mathematical school. These proponents firmly believed that the true art of war was not in fighting bloody battles but in conducting skillful maneuvers to checkmate the enemy through calculated marches and movements.[16] The ideal was to defeat the enemy not by fighting a bloody battle but to skillfully outmaneuver him. Strategy was based on abstract mathematical foundations. The commander was required to be like a chess player capable of mastering all combinations, while the army in the field was like a figure on a chessboard. Personal and creative performance



Hannibal, leader of Carthaginian forces, transiting river to battle against Rome in Second Punic War

on the battlefield did not play a great role. The actions of the great captains were explained by their adherence to rules of the art of war.[17]

The Welsh general and theoretician Henry E. Lloyd was one of the strongest proponents of the scientific approach to the study of war. He compared the army to a mechanical device, which, "like all other machines," is composed of various parts. Its perfection depends first on its parts, and second, on the manner in which these parts are arranged. He wrote that war is a branch of Newtonian mechanics. Lloyd believed that the exact knowledge of the country, as well as the science of position, camps, and marches, were essential disciplines to be mastered by a general.[18]

Unlike the other representatives of the geometrical school, Lloyd was one of the first thinkers who highlighted the need to pay attention to the morale of the troops. This was evident in his discussion of human passions as motivating factors including fear, honor, shame, and desire for riches. He wrote that the most powerful of all is the love of liberty and religion.[19]

The Prussian officer Freiherr von Bülow, one of the most influential theorists of the Enlightenment, wrote *Spirit of the New System of War* (1799). He reinforced Lloyd's scientific approach or geometric science of strategy.[20] In his view, the modern conduct of war was based on lines of operation and the introduction of firearms.[21] Bülow provided mathematically precise theory. He firmly believed that his theories could offer the key to victory by enabling scientific precision of the outcome before armies engaged in battle. He claimed to discover mathematical secrets of strategy and established them as a science. In Bülow's view, "From now on, there will be no need of crude considerations and the hazardous trial of battle in order to plan and decide the fate of campaign. If the attacker relied on an unsound base [of operations], the defender could force him to retreat without resorting to battle." Battle was made unnecessary by the scientific perfection of strategy: "War will be no longer called an art, but science. . . . The art itself will be a science, or be lost in it."[22] In contrast to Lloyd and some other theorists of the Enlightenment, who alongside the scientific parts of war left room for the creativity of a genius, Bülow asserted that "the sphere of military genius will at last be so narrowed, that a man of talents will no longer be willing to devote himself to this ungrateful trade."[23]

Postmilitary Enlightenment Era

The views of the proponents of the geometrical school were proved false with the advent of decisive warfare as practiced by the French revolutionaries and Napoleon I. However, the proponents of the military ideas of the Enlightenment did not lose influence. Their ideas were largely adopted, although in a modified form, by Antoine-Henri Jomini (1779–1869) and the Austrian Archduke Charles (1771–1847). In fact, the great majority of military theoreticians in the 19th century based their ideas on the theories developed during the Enlightenment.[24]

The Swiss-born French general Jomini avoided the trend of developing increasingly complex geometric systems of warfare, yet he built his theories on foundations laid in the Enlightenment. This, in turn, led him to take a fundamentally reductionist and predictive approach.[25] Jomini wrote that "war in its ensemble is not a science, but an art, and strategy in particular may be regulated by fixed laws resembling those of positive science but this is not true if war is viewed as a whole."[26] He argued that tactics are the only part of war that can be subjected to fixed rules.[27]

Jomini sought to identify universal principles central to the art of war and to discern them through his study of the campaigns conducted by Frederick the Great. In his seminal *Summary of the Art of War* (1838), Jomini wrote that there are some fundamental principles of war that cannot be deviated from without danger, while their application has been always crowned with success.[28] He provides a list of four maxims that made an overarching principle; even seemingly simple principles consisted of a set of subordinate tenets. Although he revised his system of principles, he never significantly diverged from the ideas that he developed by studying Frederick the Great's campaigns through the lenses of Lloyd and Bülow.[29]

Despite his obvious fixation on the principles of war, Jomini recognized the importance of moral factors in war. In his view, these factors prevented a theoretical determination of tactics. He firmly believed that despite technological changes, "strategy alone will remain unchanged, with the principles the same as under Scipios and Caesars, Frederick and Napoleon, since they are independent of the nature of the arms and organization of the troops."[30]

Archduke Charles, the son of Emperor Leopold II, was regarded as one of the best generals of the Habsburg monarchy and of Continental Europe as well. The Archduke

was also one of the better known military theorists of his era. His work was based on the ideas of the late Enlightenment. In his *Principles of Higher Art of War* (1806), he stated that "The principles of the science of war are few and unchanging. Only their application is never the same. Every change in the conditions of armies; in their arms, strength and positions, and every new invention, involved a different application of these rules."[31] In his *Principles of Strategy* (1814), Archduke Charles also adopted almost entirely Bülow's general theory of war and his geometrical concept of operations, but with less emphasis on mathematical aspects.[32]

The view that the conduct of war is largely a science and not an art was not limited to Jomini's interpreters and followers. One of the leading military theorists in the 20th century, British General J.F.C. Fuller (1878–1966), was also a firm believer that the conduct of war is largely a science. He was much influenced by Lloyd's theories. In his *Foundations of the Science of War*, Fuller wrote that scientific methods are a common sense approach on how to know the truth about the past and how we can apply this truth to the conditions that surround us now and that will probably exist during the next war.[33] Fuller asserted that war is as much a science as any other human activity because it is built on facts and that war must be reduced to science before it can be practiced correctly as an art.[34]

The Marxist-Leninist theoreticians believed that war was essentially based on scientific principles. Vladimir Lenin's (1870–1924) predilection for dialectical-materialist principles of objectivism, regularities in the nature of society, and the possibilities of knowledge strongly influenced the post-1917 development of Soviet military theory. Lenin's philosophical views were compatible with more objective scientific methods in military affairs and led toward the development of military foresight. Hence, in the Soviet military, virtually every aspect of military affairs was influenced by Lenin's ideological views.[35] The main reason for those and for similar beliefs was an unbounded faith in the extraordinary value and impact of materiel on the conduct of war. Friedrich Engels (1820–1895), one of the early and influential Marxist military theoreticians, believed that all great revolutions in warfare were the result not of great masters of war but of inventions of better weapons and changes in materiel. For him, military power was based on weapons and military equipment whose quality was dependent on the status of the development of what he and other Marxists called "production forces."[36]

The Soviet obsession with scientific Marxism-Leninism and its attendant preoccupation with history, laws, principles, norms, and rules and its attention to "objective" algorithms and formulae all artificially reduced the dynamics of the battlefield to a sterile process more akin to calculus than human struggle.[37]

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Modern Theories

Traditionally, the Western approach to conducting war has been influenced by the Newtonian quest to identify universal laws of combat by which all problems can be resolved and the results of combat predicted. Hence, extensive efforts are made to quantify everything in war. Since the mid-1990s, the systems (or systemic) approach to warfare has gradually emerged as the dominant school of thought in the U.S. military, most other Western militaries, and the North Atlantic Treaty Organization (NATO). This was exemplified by the wide acceptance in the United States and NATO and some other militaries of the claims by advocates of network-centric warfare (NCW)/network-centric operations (NCO), effects-based operations (EBO)/effects-based approach to operations (EBAO), and systemic operational design (SOD), which mutated to *operational design* and ultimately to *design*. Since their heyday in the early 2000s, the influence of NCW/NCO advocates has been greatly diminished. U.S. Joint Forces Command officially abandoned the more mechanistic elements of EBAO in the summer of 2008. However, some theoretical aspects of EBAO were retained in the main U.S. joint doctrine documents and are still used, although in a modified form, by NATO. A common characteristic of NCW/EBO/SOD is that they are based on new and largely unproven technologies. They were adopted without proper testing and were not backed by empirical evidence. They reflect the neo-Newtonian, not the Clausewitzian, view of the nature of war.

The effects-based warfare proponents embraced so-called systems of systems analysis (SoSA) to assess situations and then identify centers of gravity. SOD is based on both general systems theory and complexity theory.[38] *Design* itself is defined as a "repeatable methodology of reasoning that helps commanders understand how to change a complex-adaptive system."[39] Its declared purpose is to bridge the gap from the situation that exists at the beginning of an operation—that is, the observed-system—to the situation when operations end—that is, the desired system. The design uses some theoretical aspects of SOD and EBO but supposedly does not rely on either concept to achieve its main purpose.[40] Proponents of design acknowledge that warfare is a complex, adaptive system rather than a closed system. This, in turn, makes anticipating and evaluating the effect of one's physical actions on the enemy's behavior a significant challenge.[41]

Quantifying the Unquantifiable

Since the advent of the modern era, there have been numerous attempts to apply some elements of quantitative analysis to understanding the sources of victory. This is especially the case with those who view the conduct of war as a science. Claims have been made that the use of various quantifiable methods is more "objective" than using the commander's judgment and experience. Yet this is not true because, among other things, the decision of what to measure is highly subjective. Carl von Clausewitz (1780–1831) warned that so-called mathematical factors can never find a firm basis in military calculations. In his view, war most closely resembles a game of cards.[42]

The Russians relied on various mathematical solutions to military forecasting problems since the late 19th century. The Soviet propensity to use mathematical methods was the result of more than 75 years of study, self-criticism, and refinement.[43] The Russians derived multiple combat models for optimizing courses of action and predicting relative rates of advance on the battlefield. These

measurements were based on the outcomes of major operations and battles in the Great Patriotic War (1941–1945). The Soviets considered their methodologies dialectically and scientifically sound and, moreover, consistent with Marxist-Leninist teachings. By the early 1960s, the mathematics of armed conflict was categorized as a branch of Soviet operations research, the social science that rationally organizes goal-directed human activity.[44] The Soviet operations research tried to reduce certain tactical and technical aspects of military science to measurable objective indices so decisions could be made or substantiated. The Soviets especially emphasized the so-called correlation of forces method as a tool for tactical and operational commanders to make sound decisions. This method dealt with direct or numerical comparisons of forces, quantification of selected battlefield elements, and mathematical expressions or equations related to those elements in such a manner as to support decisionmaking.[45] Yet the Soviets did not rely solely on quantitative methods such as correlation of force and means. They also took into account the enemy's use of surprise and deception.[46]

In the West, various mathematical methods known as operations research (OR) were used for enhancing the effectiveness of certain weapons and developing tactics in their employment. The origins of OR are found in World War I. In 1914, the British mathematician F.W. Lanchester devised the so-called N-square law, which quantified the relationship between victory and superiority in numbers.[47] The OR was used in the United Kingdom in the late 1930s to find a solution to the seemingly impossible problem of successful defense against the enemy's air attacks on the British Isles. In World War II, OR was generally used in scarce radar stations and in devising the optimal search techniques and the size of convoys in antisubmarine warfare (ASW). OR also reduced the loss rate of convoys when analysts realized that larger convoys could travel more safely.[48] The United States followed the British lead and used OR in greatly increasing the effectiveness of mine warfare, ASW, and air attacks.

Systems analysis (now known as policy analysis) is another quantifiable method used in the public sector and adopted by the military. This method is concerned with the allocation of resources and is aimed to maximize the value of objectives achieved minus the value of resources used. In business, this reduces itself to maximizing profits.[49] By using mathematical methods, analysts systematically emphasized quantifiable aspects of warfare, which were susceptible to being integrated into mathematical models and input-output calculations. Anything that could not be quantified was therefore excluded. Such elements of the commander's personality as intuition, courage, and willpower were devalued.[50]

One of the strongest advocates of systems analysis in the U.S. military was Secretary of Defense Robert McNamara. During his tenure (1961–1968), he extensively used systems analysis for making key decisions pertaining to force requirements and weapons design and procurement. McNamara is perhaps best known for using quantifiable methods not only in assessing the progress of the war in South Vietnam but in making decisions based on these methods—that is, trying to conduct war as a science rather than an art. The Pentagon applied the so-called body count as the principal measurement to determine what the United States should be doing to win in Vietnam while putting U.S. troops at the least risk.[51] Yet such metrics proved meaningless. The statistical indicators pointing to U.S. success were frequently erroneous and misleading. The models on which war managers relied were equally faulty. Trapped in the mindset that the war was a purely technical problem, U.S. high officials failed to grasp the sheer determination of their opponents and the extent of the success of their political strategy.[52]

Clausewitz warned that so-called mathematical factors can never find a firm basis in military calculations

The Pentagon's emphasis on business practices has led since the late 1990s to an extensive reliance on various "metrics" in evaluating progress toward accomplishing objectives on the battlefield. These quantification methods in essence have replaced the commander's judgment, intuition, and independence of execution.[53] The use of metrics is highly subjective because higher authority arbitrarily selects which aspects of the situation should be counted and evaluated. But even if the metrics are correctly determined, it is often difficult to evaluate hidden elements in the situation.

The proponents of the systems approach to warfare also rely on some quantifiable methods to evaluate the combat potential of the opposing forces and the rate of accomplishing one's objectives. For example, the effects-based warfare proponents expanded the use of various metrics compared with their use in the traditional Military Decision Making Process. The main quantifiable methods used in EBO are so-called measures of merit. These are in turn divided into measures of effectiveness and measures of performance.

War as an Art

The view that the conduct of war is largely an art is not entirely new. Several military theorists during the Enlightenment, notably Saxe and Lloyd, realized the great importance of psychological factors in warfare. Yet they never went a step further and viewed warfare as complex and full of uncertainty, chaos, unpredictability, and even irrationality.

The most dramatic changes in military theory that led to a more refined view of warfare occurred in Germany in the late 18th and early 19th centuries. The major cultural trends in Germany were romanticism, nationalism, and idealism. German romanticism challenged the fundamentals of the French-dominated Enlightenment's worldview. It was opposed to the French cultural and political imperialism. It led to the awakening of German national sentiment. German thinkers of the "counter-Enlightenment" believed that concepts of knowledge and reality are fundamentally false, or at least exaggerated. For them, the world was not simple but highly complex, composed of innumerable and unique elements and events, and always in a state of flux. They were not as enthusiastic about Newtonian science.[54] The German Romanticists increasingly focused on the inherent complexity of nature. They argued that this complexity could not be explained by the Newtonian scientific model. The German Romanticists took a historical approach to their understanding of reality.

Soldiers return fire during firefight with Taliban forces in Barawala Kalay Valley, Afghanistan

U.S. Army (Cameron Boyd)

All comprehension was seen as the subjective result of the dynamics of one's time and place. These and similar ideas led German intellectuals to believe that reality does not conform to universal laws or principles.[55]

The new cultural trends that started as a reaction to the Enlightenment also had considerable influence on German military theorists and practitioners, notably Georg Heinrich von Berenhorst (1733–1814), Johann Gerhard von Scharnhorst (1755–1813), and Clausewitz. The first work that challenged the prevalent ideas of the military Enlightenment was Berenhorst's three-volume *Reflections on the Art of War: Its Progress, Contradictions and Certainty* (1796–1799). Berenhorst observed that the ancient Greeks and Romans brought the art of war to the pinnacle of perfection. For him, they were more "artistic" than anyone else.[56] He wrote that during the Enlightenment, the art of war, like the rest of the sciences and arts, advanced knowledge and supported innate talent. In his view, the art of war is not based on immutable laws but rather is associated with the unknown and uncontrollable modifications of the human spirit. Moral forces animate the troops; therefore, they are a major factor in the conduct of war.[57] Berenhorst believed that war, in contrast to mathematics or astronomy, could not be formulated as a science. He considered various rules and principles derived from experiences as artificial and dogmatic. They were often applied indiscriminately to a changed situation.[58]

Scharnhorst viewed the systems of conducting operations that were fashionable in his day as artificial and one-sided. The art of war was a practical science and its meaning could only be based on the study of reality. If that link is broken, then the art of war leads to abstractions.[59] In his essay "The Use of Military History, the Causes of Its Deficiencies" (1806), Scharnhorst wrote that great generals throughout history studied the principles of the art of war. Some branches of this art are even susceptible to mathematical formulation, but others are dependent on circumstances and cannot be studied mechanically. This is why study alone without genius will never make a great general.[60]

Clausewitz was the first theoretician who systematically presented a philosophy of war in all aspects. Influenced by the ideas of German romanticism, he saw the world differently from the military thinkers of the Enlightenment. He was also greatly influenced by Scharnhorst's pragmatism and relativist approach. He considered war as a complex and unpredictable phenomenon. Clausewitz believed only in broad generalities, none of which consistently held true in the fog and friction of actual combat.[61] He argued that a system fails to account for the "endless complexities involved" in war and therefore results in a theoretical construct that bears little resemblance to the actual practice of war.[62] Hence, he considered any attempt to reduce the complex phenomena of war to a simple system of universal principles as an exercise in futility.[63]

Clausewitz believed that war belongs to the domain of social life; it is neither a science nor an art. It is not a science because it is a matter of action, and it is not an art because it exerts itself not on inanimate or passive human material but on reacting, living force.[64] Clausewitz wrote that the "art of war must always leave a margin for uncertainty in the greatest things and in the smallest. The greater the gap between uncertainty on the

one hand and courage and self-confidence on the other hand, the greater the margin that can be left for accidents."[65]

The human factor largely determines what is called the "nature" of war—those constant, universal, and inherent qualities that characterize any war throughout the ages. The nature of war is unchangeable regardless either of shifting motives and forms of war or of technological advances.[66] Human behavior is a major part of the nature of war. Clausewitz's greatest contribution to our understanding of war was his analysis of the importance of the human factor and the psychological element in particular in the conduct of war. He wrote that warfare is shaped by human nature, complexities of human behavior, and limitations of human and physical conditions. The material and psychological aspects of a war form an organic whole; they are inextricably linked.[67] He wrote that war is not the action of a living force on a lifeless mass but the collision of two living forces that interact.[68] Victory does not consist only in the conquest of the battlefield, but in the destruction of the physical and moral fighting forces.[69]

The principal psychological features of any war are hatred, hostility, violence, uncertainty (or fog of war), friction, fear, danger, irrationality, chance, and luck.[70] For Clausewitz, a war was a trinity composed of primordial violence, hatred, and enmity—a blind natural force.[71] Clausewitz observed that danger is "a part of the friction of war and without accurate conceptions of danger one cannot understand war."[72] Moreover, war is "the realm of physical exertion and suffering."[73] It is full of chances and probabilities within which the creative spirit is free to roam.[74] Clausewitz wrote that nowhere do accidents have such a free playing field as in war. Not only its objective but also its subjective nature makes war a gamble.[75]

Clausewitz observed that "The great uncertainty of all facts presents a peculiar difficulty in war, because all actions take place in something virtually akin to dusk, which in addition like fog or moonlight, gives the objects an exaggerated size and a grotesque view."[76] He pointed out that the only situation a commander can know fully is his own. The commander's knowledge of the enemy's situation is often based on unreliable information. His evaluation therefore may be mistaken and can lead him to assume that the enemy has the initiative when in fact he himself could have it. Such a faulty appreciation is as likely to lead to ill-timed action as to ill-timed inaction.[77] Clausewitz argued that friction is the only concept that quite generally fits the difference between real war and war on paper.[78] He argued that this "tremendous friction, which cannot as in mechanics, be reduced to a few points, is everywhere in contact with chance, and brings about effects that cannot be measured, just because they are largely due to chance. Friction is the force that makes the apparently easy so difficult."[79] Friction encompasses uncertainties, errors, accidents, technical difficulties, and the unforeseen, and their effects on one's decisions, actions, and morale.[80]

Helmuth von Moltke, Sr., stated that most of what constitutes the operation of armies is essentially grounded in science, while the art comes to the fore when the wills of opposing commanders meet.[81] For him, the scientific method was anathema. He held that nothing in war is certain. Therefore, in war as in art there "exist no general rules; in neither can talent be replaced by precepts. And given the uncertainty of war, Moltke concluded that strategy could not be more than a system of expedients."[82] He created an environment that cultivated creativity, improvisation, inventiveness, and open-mindedness.[83]

Clausewitz's greatest contribution to our understanding of war was the importance of the human factor and the psychological element in particular

During the tenure of Field Marshal Moltke, Sr., as chief of the Prussian/German Great General Staff (1857–1888), the Clausewitzian teachings on war were widely shared by the Prussian/German theorists and practitioners. The Germans believed that no sphere of human activity, conditioned as it was by its historical setting and dominated by a multitude of acts, could ever be compressed into a formal system of rules and principles. This cultural premise was introduced by Clausewitz.[84] The Germans considered warfighting more of an art than a science. They believed no one could control events in a war. Any war is full of ambiguity, confusion, and chaos. In a war, the absolute cannot be achieved, nor can uncertainty be mastered. A margin must always be left for uncertainty. Moltke explained that in war, "everything was uncertain; nothing was without danger, and only with difficulty could one accomplish great results by another route. No calculation of space and time guaranteed victory in this realm of chance, mistakes, and disappointments. Uncertainty and the danger of failure accompanied every step toward the objective." The Germans accepted the confusion of battle as an unending source of potential opportunities and built a command and control philosophy, known as the mission command (*Auftragstaktik*), in which that potential could be realized through decentralized decisionmaking.[85]

During the interwar years (1919–1939), the Germans considered war a free and creative activity, or an art. It makes high demands on human personality. At the same time, warfare is founded on scientific principles. New weapons dictate ever-changing forms. Their appearance must be anticipated and their influence evaluated. Afterward, they must be put in service quickly. Combat situations are diverse; they change often and suddenly and can seldom be anticipated in advance. Incalculable elements have a decisive influence, particularly as one's own will is pitted against the independent will of the enemy. Friction and errors are daily occurrences.[86]

Clausewitzian views on the true nature of war remain valid today. The human element is the single most critical aspect of warfare. Human nature has changed little despite vast changes in military technologies. Warfare is too complex and unpredictable an activity to be taken over by machines or explained and managed by pseudoscientific theories. Only the human brain is fully capable of reacting in a timely and proper fashion to the sudden and unanticipated changes in the situation and countering the enemy's actions and reactions. The enemy has his own will. He can react unpredictably or irrationally.

The timing and scope of irrationality cannot be predicted or measured. Irrational decisions on either side in combat can have significant consequences on both the course and the outcome of a war. Perceived irrationality is often the reflection of one's cultural values in evaluating the enemy's actions and reactions. An enemy commander is a product of a different society, traditions, and culture. Hence, he may make decisions that are considered irrational although they are fully consonant with his own societal values and military culture. Psychological states of the individuals or groups and their possible reactions under stress cannot be entirely known. This is even more true when dealing with enemy forces.

during the interwar years, the Germans considered war a free and creative activity, or an art

Conclusion

The question of whether the conduct of war is largely a science or an art is by no means settled. This is mainly due to the inherent human proclivity to seek certainty in all domains of social life, including warfare. Another factor is the influence of Newtonian scientific theories and almost blind faith in the power of advanced technologies. Yet numerous attempts to make the conduct of war largely or exclusively a science have repeatedly failed. Warfare is too complex, chaotic, and unpredictable to be conducted by using scientific methods, no matter how advanced. This is not to underestimate or ignore the importance of science in military affairs. Science and technology were and will remain major factors in the ever-changing character of war. History is replete with examples where science and technology have made the difference between victory and defeat.

Scientific methods should be extensively used in explaining the phenomena of war in general and all its aspects. Sound theories of war are based on the use of scientific methods. Various business models can be successfully applied in managing military organization, force planning, and designing of weapons. Quantifiable methods can be useful in assessing and enhancing the use of individual platforms and their weapons/sensors and their tactics. However, the utility of such methods is progressively diminished when they are applied at the operational and strategic levels of war where intangible elements play a major role in the course and outcome of war.

In short, there is a huge difference between using science and technology to enhance the combat potential of one's forces and applying scientific methods in the conduct of war. Our knowledge and understanding of warfare is a science, but the conduct of war itself is largely an art. This will not change in the future regardless of scientific and technological advances. As in the past, the character of war will change, even dramatically, but the nature of war as explained by Clausewitz will not. Warfare would be relatively simple, predictable, and controllable but for its intangibles—the human factor and its psychological elements. **JFQ**

NOTES

[1] Antoine Bousquet, *The Scientific Way of Warfare: Order and Chaos on the Battlefields of Modernity* (New York: Columbia University Press, 2009), 9–10.

[2] Donald E. Neill, "Ancestral Voices: The Influence of the Ancients on the Military Thought of the Seventeenth and Eighteenth Century," *The Journal of Military History* 62, no. 3 (July 1998), 488.

[3] Azar Gat, *A History of Military Thought from the Enlightenment to the Cold War* (Oxford: Oxford University Press, 2001), 9.

[4] Cited in Bousquet, 15.

[5] Ibid., 38.

[6] Neill, 507.

[7] Ibid., 506.

[8] Thomas M. Barker, *The Military Intellectual and Battle: Raimondo Montecúccoli and the Thirty Years' War* (New York: State University of New York Press, 1975), 5.

[9] Robert S. Quimby, *The Background of Napoleonic Warfare: The Theory of Military Tactics in Eighteenth-Century France* (New York, AMS Press, 1968), 16.

[10] Cited in Gat, 37–38.

[11] Eugene Miakinkow, "A Russian Way of War? Westernization of Russian Military Thought, 1757–1800" (MA thesis, Waterloo, Ontario, 2009), 19.

[12] Cited in J.F.C. Fuller, *The Foundations of the Science of War* (London: Hutchinson & Co., 1926), 24.

[13] Ibid., 294.

[14] Cited in Gat, 31.

[15] Miakinkow, 29.

[16] Guenther Blumentritt, Die Gedanklichen Grundlagen des Alten O.K.H in O.v. Natzmer, *Die Gedanklichen Grundlagen des OKH und deren Auswirkungen auf seine Organisation. Ein Schlusswort zur Gesamtarbeitt "OKH,"* December 1949, ZA/1 1935 P-041kk, Freiburg, i.Br, Bundesarchiv-Miliaterarchiv, 10.

[17] Reinhard Hoehn, *Scharnhorts Vermaechtnis* (Bonn: Athenaum Verlag, 1952), 67.

[18] Cited in Armstrong Starkey, *War in the Age of Enlightenment, 1700–1789* (Westport, CT: Praeger, 2003), 57.

[19] Ibid., 58.

[20] Mark T. Calhoun, "Clausewitz and Jomini: Contrasting Intellectual Frameworks in Military Theory," *Army History*, no. 80 (Summer 2011), 25.

[21] Gat, 81.

[22] Ibid., 84.

[23] Ibid.

[24] Ibid., 142.

[25] Calhoun, 27.

[26] Cited in Gurbachan Singh, "The Science of War," available at <www.mindef.gov.sg/content/imindef/publications/pointer/journals/2007/v33n1/feature7.print.html?Status=1>.

[27] Cited in Gat, 115.

[28] Singh.

[29] Calhoun, 27.

[30] Cited in Gat, 115–116.

[31] Ibid., 101.

[32] Ibid., 104.

[33] Cited in Singh.

[34] Anthony John Trythall, *"Boney" Fuller: Soldier, Strategist, and Writer, 1878–1966* (New Brunswick, NJ: Rutgers University Press, 1977), 115.

[35] James K. Womack, *Soviet Correlation of Forces and Means: Quantifying Modern Operations* (Fort Leavenworth, KS: School of Advanced Military Studies, U.S. Army Command and General Staff College, 1990), 13–14.

[36] Herfried Muenkler, *Ueber den Krieg. Stationen der Kriegsgeschichte im Spiegel ihrer theoretischen Reflexion* (Weilerswist: Velbrueck Wissenschaft, 2002), 128–129.

[37] William P. Baxter, *The Soviet Way of Warfare* (London: Brassey's Defence Publishers, 1986), 242.

[38] Cited in William G. Cummings, *Operational Design Doctrine: Hamstrung or Footloose in the Contemporary Operating Environment* (Toronto: Canadian Forces College, April 30, 2007), 74.

[39] U.S. Joint Forces Command, Joint Doctrine Series, Pamphlet 10, *Design in Military Operations. A Primer for Joint Warfighters* (Norfolk, VA: Joint Warfighting Center, September 20, 2010), 3.

[40] Ibid.

[41] Justin Kelly and David Kilcullen, "Chaos Versus Predictability: A Critique of Effects Based

Operations," *Australian Army Journal* 2, no. 1 (Winter 2004), 90.

[42] Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (New York: Knopf, 1993), 97.

[43] Womack, 84.

[44] Ibid., 2.

[45] Ibid., 32.

[46] Ibid., 81.

[47] Cited in M. Kirby and R. Capey, "The Air Defense of Great Britain, 1920–1940: An Operational Research Perspective," *The Journal of the Operational Research Society* 48, no. 6 (June 1997), 558.

[48] Bousquet, 141.

[49] Ibid., 149–150.

[50] Ibid., 151.

[51] Robert McNamara with Brian Vandemark, *In Retrospect: The Tragedy and Lessons of Vietnam* (New York: Random House, 1995), 237–238.

[52] Bousquet, 157.

[53] Dieter Stockfisch, "Im Spannungsfeld zwischen Technologiefortschritt und Fuehrungsverstaendniss. Auftragstaktik," *Marineforum* 12 (December 1996), 13.

[54] Gat, 144.

[55] Calhoun, 27.

[56] Cited in Gat, 154.

[57] Ibid., 155.

[58] Ibid., 156.

[59] Reinhard Hoehn, *Scharnhorts Vermaechtnis* (Bonn: Athenaum Verlag, 1952), 73.

[60] Gat, 168.

[61] Calhoun, 25.

[62] Ibid., 28.

[63] Ibid., 27.

[64] Trythall, 116–117.

[65] Clausewitz, 97.

[66] Michael Sheehan, "The Changing Character of War," in *The Globalization of World Politics: An Introduction to International Relations*, ed. John Baylis, Steve Smith, and Patricia Owens, 216, 4th ed. (Oxford: Oxford University Press, 2007).

[67] Clausewitz, 216.

[68] Ibid., 86.

[69] Cited in Beatrice Heuser, *Reading Clausewitz* (London: Random House, 2002), 81.

[70] Sheehan, 216.

[71] Cited in Ian Roxborough, "Clausewitz and the Sociology of War," *The British Journal of Sociology* 45, no. 4 (December 1994), 625.

[72] Clausewitz, 133.

[73] Ibid., 116.

[74] Cited in Roxborough, 625.

[75] Clausewitz, 96.

[76] Cited in Heuser, 89.

[77] Clausewitz, 95.

[78] Cited in Heuser, 88.

[79] Clausewitz, 139–140.

[80] Peter Paret, "Clausewitz," in *Makers of Modern Strategy: From Machiavelli to the Nuclear Age*, ed. Peter Paret, Gordon Craig, and Felix Gilbert, 202 (Princeton, NJ: Princeton University Press, 1986).

[81] Daniel Hughes, *Moltke on the Art of War: Selected Writings* (Novato, CA: Presidio Press, 1993), 172.

[82] Gabriel Serbu, "The Dangers of Anti-Intellectualism in Contemporary Western Armies," *Infantry* (November/December 2010), 45.

[83] Ibid., 47.

[84] Gat, 332.

[85] Hughes, 175.

[86] Bruce Condell and David T. Zabecki, eds., *On the German Art of War:* "Truppenfuehrung" (Boulder, CO: Lynne Rienner, 2001), 17.