The Links between Science, Philosophy, and Military Theory

Understanding the Past, Implications for the Future

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Abstract

This study examines the links between science, philosophy, and military theory. The author uses two case studies to demonstrate the links between these disciplines. He presents an overview on the rise of Newtonian science, and he examines how the key frameworks and concepts of that science became interwoven into Western civilization to affect its philosophy with an emphasis on its interpretation by the German Romanticist philosopher Immanuel Kant. He then shows how Newtonian science and Kant's philosophy affected the military theory of Carl von Clausewitz. His second case study concerns the theory and philosophy of evolution developed by British philosopher Herbert Spencer and its influence on the military theory of J. F. C. Fuller. The author compares these two case studies to find commonalities between them that suggest a mechanism which explains how and why scientific theory and their philosophical interpretations eventually influence military theory. The author then uses this mechanism as a tool with which "new" sciences such as quantum mechanics, relativity, and complexity theory can be evaluated to see if and in what manner they will affect future military theories. The main concept of this mechanism is that science and philosophy, both consciously and unconsciously, provide frameworks for investigation and systems of knowledge for the military theorist. Finally, this study suggests that new definitions of the concepts of force, space, time, and knowledge will have an influence on future military theory. The shift from the Newtonian framework of cause and effect determinism to the new science concept of probabilities and trends—as well as the shift from the force of heavy mechanics to the new particle wave theories of force—will change man's concept of the battlefield, emphasizing the capability for rapid observation and action.

About the Author

Lt Col Robert P. Pellegrini, United States Army, was commissioned into the Regular Army through the Reserve Officers Training Program, University of Pittsburgh in 1977. He was initially assigned to the Army Ordnance Corps and after graduation from the US Naval School, Explosive Ordnance Disposal, he served as a bomb disposal detachment executive officer and commander. In 1981 he transferred to the infantry branch and held various infantry assignments in the 101st Airborne Division (air assault) and the 10th Mountain Division (light infantry). Colonel Pellegrini also served two tours with the Multinational Force and Observers peacekeeping mission in the Sinai peninsula. He holds a bachelor's degree in history and journalism from the University of Pittsburgh and a master's degree in history from Gannon University, Erie, Pennsylvania. He is the first Army officer selected to attend the School of Advanced Airpower Studies. In August 1995 Colonel Pellegrini was assigned to the US Army First Corps Operations Section (G3), Fort Lewis, Washington.

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Chapter 1

Introduction

Modern military theory was born out of the French Revolution and the wars that followed. This revolution, against the Sun King, Louis XVI, started an upheaval in Europe which swept away all that had existed, established a new order in France, and created a new model for society in Europe. The military theory of the Enlightenment which postulated small, expert armies carrying out warfare in a scientific manner was also swept away by Napoléon with the same decisiveness with which he dispatched the Prussian army at Jena. Carl von Clausewitz, one of the participants in this war and the subject of a large part of this study, wrote "Bonaparte's audacity and luck have cast the old accepted practices to the winds. Major powers were shattered with virtually a single blow."[1] In reaction to these wars, Clausewitz and Henri de Jomini each produced military theories in order to describe the new character of war.

The seeds of the French Revolution can be traced to another revolution that had occurred two and one-half centuries earlier. This revolution produced equally sweeping changes and was also a revolution concerning a sun. In 1543 Polish cleric Nicolaus Copernicus (1473–1543) published *The Revolution of the Heavenly Orbs* that postulated a sun-centered universe rather than the earth-centered universe that had been accepted for 1,500 years. The use of the term *revolution* to describe upheavals in beliefs and societies, rather than to describe an action in physics, comes from this issue and this time.[2] *The Revolution of the Heavenly Orbs* started a process that changed the way man viewed not only the solar system but his understanding of science, his society, and even his god. Modern science then was born out of this revolution and grew into Newtonian science, which in turn was the foundation of the Enlightenment that sought to understand the laws of nature and apply them to all endeavors. It was natural laws, therefore, that governed man who was also heir to natural rights—royalty was now viewed as an unnatural phenomenon. In a general and indirect way, the publication of a book in Germany in 1543 about Earth's movement around the Sun helped to create conditions that led to the regicide of the Sun King in 1789.

Out of these two revolutions came what we consider to be "modern" science and military theory. Newtonian science dominated Western civilization both as a framework for scientific investigation and as an idea that the universe was ordered, mechanistic, and predictable. The concept of the "Majestic Clockwork," however, was seriously undermined by the discovery of quantum mechanics and the special and general laws of physics that show that man's understanding of the universe will always be incomplete and tenuous. Work in biology—especially desoxyribonucleic acid (DNA) and the workings of the human brain—artificial intelligence, and chaos and complexity theories now suggest that the world is composed of complex systems which interact with, and adapt to, each other making it even more difficult to obtain knowledge about how the universe functions.

If it is true that Newtonian science affected the development of military theory (and it will be shown here that it did), will these new sciences influence future military theory? A glance at professional military journals reveals articles on such topics as cyberwar, the military-technical revolution, chaos and warfare, and the now ubiquitous infowar. Are these merely today's fads—as useful and as dating as tail fins of a family sedan, circa 1960—or do they reveal a true change in the character of war? In these instances, are military thinkers consciously basing their ideas on a scientific foundation; and if so, do they understand that science adequately enough to use it correctly? Perhaps by examining previous instances of the scientific and philosophical influence on military theory, it may become possible to answer these questions.

This study assumes that military thinkers are part of a general society and live in the same river of experience as do other educated persons of their time. The culture they live in has been fed from the same tributaries and headwaters, and they are subject to the same eddies and currents of thought. Certain members of our civilization, the scientists, attempt to understand that environment and to widen its banks; other members, the philosophers, describe how people can best comprehend and interact with the environment. In the end, the military theoreticians are influenced by the philosophic and scientific currents that define the world simply because they are subjected to the same forces as the rest of society.

This topic has been dealt with, in part, many times before from many different perspectives. General histories of science and of Western civilization usually show the connection between science and philosophy but never their impact on military theory. Military histories usually discuss in general terms the philosophical influences which affected military theorists but seldom discuss the scientific genesis of these influences.[3] The aim of this study is to describe the path by which specific scientific concepts and frameworks, along with their philosophical interpretations, eventually influence military theory. At times, scientific concepts and frameworks have been applied by the military theorist uninterpreted by anyone except himself. At other times, he was influenced by someone—a philosopher—who had synthesized these scientific influences into a coherent view of the world. Essentially, the role of the scientist in this process has been to describe the nature of the universe. The philosopher then described man's place in this universe. Finally, the military theorist described how man best conducts war in this universe.

Appropriately enough, this study uses the method of investigation outlined by Sir Isaac Newton (1642–1727).

1. Analyze observed facts to discover the principles involved ("deducing principles from phenomena").

2. Then make all the relevant phenomena of the field under investigation intelligible by fitting them into a coherent system.

3. Verify physical reality of these conclusions by experiment.[4]

The "phenomena" to be observed will consist of two case studies. The first study deals with the connection between Newtonian science, the philosophy of Immanuel Kant (1724–1804), and the military theory of Clausewitz. The second case study deals with the theory of evolution of Charles Darwin (1809–1882), the philosophy of Herbert Spencer (1820–1903), and the military theory of J. F. C. Fuller (1878–1966).

The second step—"to make all the relevant phenomena of the field under investigation into an coherent system"—will be to find commonalities between the two case studies and find those themes, concepts, and frameworks that can be traced from science and philosophy to military theory. In this way, hopefully, an "intelligent system" or mechanism portraying the interaction between science, philosophy, and military theory can be achieved.

The last step will be to apply this mechanism to the "new sciences" and suggest which of these will provide a foundation for future military theories. Having selected a likely candidate, this study suggests in general terms the form future military may take based on the key aspects of this new science.

Notes

1. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, N.J.: Princeton University Press, 1976), 220.

2. Jacob Bronowski, *The Ascent of Man* (Boston: Little, Brown & Co., 1973), 178. The book is a companion piece to the acclaimed PBS series which ran in 1974.

3. There are many works such as Peter Paret's *Clausewitz and the State*, Raymond Aron's *Clausewitz, Philosopher of War,* and Azar Gat's *The Development of Military Thought* that discuss the philosophical underpinnings of various military theorists. None of them, as far as I know, has traced specific concepts back to their scientific foundations

4. John Henry Randall, *Career of Philosophy,* vol. 2, *From the German Enlightenment to the Age of Darwin* (New York: Columbia University Press, 1965), 376. Newton's original words were that the field should be placed into an "intelligible *mathematical* system."

Chapter 2

The Rise of Newtonian Science

This fool wished to reverse the entire science of astronomy; but sacred Scripture tells us that Joshua commanded the Sun to stand still, and not the Earth.

—Martin Luther, 1539, speaking of Copernicus

Early in the eighteenth century, European astronomers noted that the movement of Uranus was erratic in its journey around the Sun compared to the way it *should* move if Newton's laws of motions were correct. So great was their faith in the laws of motion, no one questioned the accuracy of the theory; instead, they looked for forces that kept Jupiter from conforming with those laws. In 1846 just where Newton's laws of motion said it would have to be to create the erratic behavior, they located an object—Neptune—whose gravitational force accounted for Uranus's deviation from its orbit. Newton's Majestic Clockwork was keeping time perfectly.

The confidence of this prediction was the product of a long process of discovery and a synthesis of ideas. Embedded in the notion of Newtonian science are concepts and frameworks which were the result of two thousand years of Western civilization. In a sense, Newtonian science was a pantheon which stood for that civilization. The standard metaphor for Newton's universe, the Majestic Clockwork, emphasizes its philosophical implications: a world that was orderly, predictable, and understood.

A study of the evolution of science from the late Middle Ages to the age of Newton will show how certain concepts and frameworks became part of Western civilization. This review is especially important since Newtonian science became the model for virtually all other sciences and social sciences and, by default, military theory. Our examination of science focuses on one field of study, the science of motion. It was the science of determining why and how objects (from planets circling the sun to apples falling from trees) move that differentiates the Middle Ages concept of a universe seeking rest to the seventeenth century concept of a universe constantly in motion.

Until the sixteenth century, Western civilization was still operating under the influence of Greek philosophy (really a mixture of what we term science and philosophy), cloaked in the robes of the Catholic church. Greek philosophy had reemerged in the eleventh century when Arab copies of the Greek classics became available and were translated into Latin. In the universities of medieval Europe, these classics became the foundation of knowledge second only to the Bible. In fact, the works of the Greeks, through the skillful interpretation of medieval scholars such as Saint Thomas Aquinas, were used to prove the validity of the Bible and the existence of God. In a very real sense, it was science used in support of theology.

The Bible and the science of Aristotle provided a model for the universe. They described a world ideally in a state of rest during a period when the average peasant spent his entire life within a radius of a few miles of his birthplace. The Bible described how the earth was created and how it would end. It prescribed laws for living.[1] Each object had an ideal nature and, in fact, all motion was attributed to objects seeking their ideal nature; motion was, therefore, attributed to a change of place.[2]

Greek philosophy and the form of Western knowledge which adopted it in support of theology (known as Scholasticism) had all the basic ingredients of theory: it provided order in their descriptions; it explained the phenomena of daily life and, within the acceptable tolerances of the day, it predicted outcomes of these phenomena. In this stable world, it also explained why some men were born to be tenant farmers or carpenters (and why their sons would be so as well) and why others were born to be priests and noblemen: it was simply because that was the natural order of things.

The most appropriate symbol of medieval science is the Ptolemaic system. Ptolemy was a Leventine Greek who, in approximately A.D. 150, updated the earth-centered universe of the Greeks by describing an accurate scheme in which planets moved on circles (known as epicycles) within their orbits.[3] This system, refined by Arab astronomers, survived almost a millennium and a half. It survived this long for the simple reason that it worked. It was predictive enough to be used for navigation, to determine time, and to construct astrological charts.

The Ptolemaic system consisted of six planets, the moon, and the sun which evolved around the earth. Each planet was embedded in a rotating glass sphere, and the stars were embedded in the final sphere which was the boundary of the universe. The light from the stars was simply reflected light from the sun. In describing the motion of the planets, however, each was treated differently; that is, the mathematical formula used to describe the motion of Mars, for example, bore no resemblance to that of Venus. The Ptolemaic system was, essentially, seven separate systems which had to be continually updated mathematically in order to “save the appearance” of the phenomenon (i.e., to match the theory with the observed event). By the sixteenth century, the accumulated changes had made the theory both elegant and complex.[4]

In reality *Revolution of the Heavenly Orbs* did no more than attribute the observed positions of the planets to the daily rotation of the earth and the movement of the planets around the sun. This idea was not new (it had been advocated by the classical Greek scientist Aristarchus and had been considered by Ptolemy), but Copernicus’s math showed that the perceived reality of the universe could be made mathematically more simple. While the Copernican system was used to develop more accurate astronomical tables, it was not generally accepted as an accurate description of reality for almost the entire next century. The Copernican system seemed so absurd, in fact, that the Catholic church didn't get around to condemning it until 1616.[5]

As the sixteenth century wore on, the mathematics of motion and the tools of observation had progressed to the point where flaws in the Ptolemaic universe could no longer be ignored. One of the scientists who highlighted these flaws was, ironically enough, committed to it as a description of reality. Tycho Brahe (1546–1601), the Danish court astronomer, improved the accuracy of astronomical data by a factor of 10 through improved methods of observation and the creation of more accurate instruments. Brahe could no longer ignore the inaccuracies of the Ptolemaic system. He devised a new model which was a hybrid of the Ptolemaic and Copernican universe. Earth remained the center of the universe (which, philosophically, was the important thing) but in which the planets revolved around the Sun, and all of them revolved around Earth.[6]

In 1600 a year before his death, Brahe took a young astronomer and mathematician as his assistant. Johannes Kepler (1571–1630) was born to a modest German family. Through the largess of the local Protestant ruler, Kepler won a scholarship to the University of Tübingen where he studied for the clergy. Mystical and moody, he was judged by the faculty to be too passionate for this line of work and was encouraged to study mathematics and astronomy. Ironically, he found work in a Catholic university and managed to avoid expulsion during periods of religious strife because his mystical views were considered too odd by both Catholics and Protestants to be easily categorized. Eventually, however, he was forced to flee and find work with Brahe in Prague.[7]

When Brahe died in 1601, Kepler inherited the most accurate stellar and planetary data ever assembled. Even though Kepler had disagreed over the model of the solar system (Kepler openly advocated the Copernican system), he respected Brahe's ability and his superb data. In accordance with Brahe's wishes, he attempted to construct new astronomical tables with this data based on all the existent models: the Ptolemaic, the Copernican, and Brahe's hybrid. While constructing the formula to describe Mars' orbit in the Copernican model, he could not reconcile an error of eight degrees between the observation and the math. Despite the fact it was almost axiomatic in astronomy that planets had to move in the perfect circles of Greek science, he realized that for the model to work, planets had to move in nasty, crude elliptical orbits. Furthermore, he described this mathematically by showing that each planet moved not at constant speeds, as had been thought, but that the line between the center of the planet and the center of the sun sweep out equal areas in equal time. These two discoveries put the solar system on one formula: gone were the complex circles within circles.[8] Kepler, however, could not explain what force propelled them around the sun. The pivotal work in that explanation would be done by Kepler's contemporary Galileo Galilei (1564–1642).

Galileo was a practical man. He was more interested in the way things really were as opposed to how they appear or with those models that were made to represent those appearances. He knew that appearances sometimes actually hide the true nature of things, celestial phenomena could be represented in countless ways, and that the mathematics alone were not sufficient to prove any theory. He was not concerned with the details of the Copernican system but in its philosophy—that the earth was the center of the universe.[9]

His first attack on the Ptolemaic system was based on physical evidence. In 1609 Galileo constructed his first telescope and immediately turned it toward the night sky.[10] In a very short time, he found physical evidence that the Ptolemaic system had to be incorrect: Moon orbiting Jupiter (which meant that Earth was not the center of all celestial movement), the phases of Venus, and the rotation of the Sun.[11] Most of these things, however, could be accounted for by other explanations such as Brahe's model of the universe.

The best support for the Copernican system, therefore, would be to attack the very heart of classical physics that had also (unfortunately for Galileo) become the religious dogma of the holy church. The Aristotelian universe had to be destroyed. Two key elements of classical science were that falling objects achieved their velocities instantaneously and that the speed of falling objects were proportional to their weights. What Galileo discovered about the effects of gravity on falling objects was important. More important, however, is *how* he determined these effects.

In casual observation, Aristotle's physics appeared valid: cannonballs and feathers did not fall at the same speed, and acceleration was hard to discern with the naked eye. Galileo said that it didn't matter; what appeared to our senses actually masked the true nature of the phenomena. To understand the mechanics of falling objects, one had to postulate the action in an environment free of outside interference (such as air which produced *friction*). This environment was a vacuum, which was not yet attainable in science. Therefore, Galileo actually had to postulate an unreachable environment that produced an ideal (or, if you will, an *absolute*) state of conditions.

A. Rupert Hall discussed the importance of the use of an ideal condition. "Only by imagining an impossible situation can a clear and simple law of fall be formulated, and only by possessing that law is it possible to comprehend the complex things that actually happen. Idealism (or abstraction) is not delusion because it ignores the complexities and discrepancies of reality; on the contrary, only through idealism can the reality explaining the complexities and discrepancies be discerned."[12]

The force which caused objects to fall, gravity, had to be understood in its pure form. In reality, it never worked according to the formula that describes falling bodies, but the formula that was the *necessary* part of the mechanism remained valid despite the friction from the air or the aerodynamic shape of the object.[13] Once the basic mechanism of a phenomenon of gravity was understood in an ideal state independent of outside disturbances, it then became a tool to understand the nature of the friction itself. In a self-propagating chain of discovery, a better understanding of those elements which constitute friction allowed for empirical testing of the ideal state.

Galileo exhibited for the first time what is at the heart of modern scientific method: a balance between intuitive thought and empirical testing. Galileo believed that nature was too complex to be understood by empirical testing alone; only by reasoning could we comprehend its perfect nature. But the human mind was also fallible, and pure reasoning without physical evidence was of little use. Therefore, a dialectical process by which a discovery of reality through experiment contrasted to an ideal state produced a better understanding of the true nature of a phenomenon.

In the end, Galileo described mathematically the acceleration of a falling object and the principle of inertia. These, along with a body of work in optics, pendulums, and the study of projectiles, resulted in effectively destroying Aristotelian physics—and the Aristotelian description of the universe which the Catholic church had used as scientific support for its teachings. For his efforts, Galileo was charged with heresy of supporting the Copernican solar system and was tried before a court of inquisition. Shown the instruments of torture and already in his seventies, Galileo recanted.[14] He was placed under house arrest for the next 10 years until his death in 1642. On Christmas day of the same year, Newton was born.

Newton was vain, argumentative, and moody. Paranoid, as well, he spent most of his life defending the primacy of the discoveries made early in his career. The man credited with the age of science and the Enlightenment was also a mystic who delved into the occult.[15] Yet, Newton as a symbol and Newtonian science as a method were to shape the way Western civilization thought about the nature of the universe, man, and God. Scientist-philosopher Bertrand Arthur Russell went so far as to maintain that owing to the rise of Newtonian science, "In 1700 the mental outlook of educated men was completely modern; in 1600, except among a very few, it was still largely medieval."[16]

To understand Newton's impact on Western civilization and military theory, it is necessary to examine Newton's work. Like Galileo, however, the actual discoveries are of less importance for this study than the method and conceptual frameworks used to attain these discoveries. Newtonian science's influence on Western philosophy is so pervasive that it affected not only other branches of science but all forms of human endeavor to include military theory.

Newton was born on a small farm in Woolsthorpe, Lincolnshire. He entered Trinity College, Cambridge, in 1661. He was elected scholar of the college in 1664 and a fellow in 1665. A plague in 1665 took him back to Woolsthorpe. It was here that in the next two years he did much of his work on the laws of motion and gravitation. "For in those days," Newton wrote, "I was in the prime of my age for invention, and minded Mathematics and Philosophy more than at any time since."[17]

Newton continued his work on physics (and in many other branches of science) while teaching at Cambridge, but he never published his findings. This led to arguments for the rest of his life with other scientists over who had first made various discoveries.[18] In 1685, for example, Edmund Halley told Newton that he despaired of finding the mathematical solution to proving the inverse-square law. Newton responded that he had solved that (the one thing the best minds of England were vainly searching for) two years previously. In that same year, he managed to connect, mathematically, the force which acts on objects on earth (e.g., the apocryphal apple) with the force affecting planetary motions.[19]

Having finally tied together the physics into a comprehensive theory, Newton published *Philosophiae Naturalis Principia Mathematica* (financed by Halley) in 1687. In it he described his laws of motion.

> I. Every body continues in its state of rest of uniform rectilinear motion unless compelled to change its state by the action of forces.
>
> II. The change of motion is proportional to the force acting, and takes place along the straight line along which the force acts.
>
> III. There is always a reaction equal and opposite to action; or, the actions of two bodies on each other are always equal and opposite.[20]

Newton had united Galileo's laws of falling bodies and his own studies of inertia and Kepler's ellipses with his computations on gravitation. Essentially, each planetary object was actually in a constant state of fall and subject to the same laws of gravitation as an earthly falling body, but the unimpeded inertia of the planetary objects in the vacuum of space caused them to move forward as well, deflecting the rectilinear trajectory. This action produced an elliptical orbit around the body that had the greater mass.[21] In *Principia* and *Optics* (published in 1704) Newton synthesized the works of Galileo, Kepler, and a host of other scientists to create an encompassing view of the universe. At the root of this science was the idea that there was order in everything. It was up to man to find this order, a connection between seemly random phenomena, and tie them into a common plan.

Newtonian science has been called a symbol of both a method and an idea. The method was a continuation of Galileo's mix of empirical data supporting intuitive thought. Newton himself was a synthesis of what has become known as the French intuitive method of scientific reasoning and the British empirical method of determining reality. The French (exemplified by René Descartes) scientific method seldom tested their hypotheses by experiment that were often, while highly innovative and original, wrong. The British scientist would conduct experiment after experiment to discover the properties of nature without tying them together to produce a mechanism of why things occurred. This was the scientific method of Francis Bacon (1561–1626) who believed that all knowledge came from empirical testing.[22]

In a letter to the secretary of The Royal Society in 1672, Newton wrote, "If anyone offers conjectures about the truth of things from the mere possibility of hypotheses, I do not see how any thing can be determined in any science; for it is always possible to contrive hypotheses, one after another, which are found rich in new tribulations."[23] Hypotheses were relevant only as a way to explain observed phenomena. Once such a hypothesis was made, it would have to be verified by experiment.

To comprehend the universe, Newton felt he had to postulate the existence of absolute time and space as set reference points for the observed universe. In *Principia* Newton wrote that absolute time is "in its own nature, without regard to anything external, always similar and immovable." Absolute time also exists "of itself and from its own nature, always flowing equably without regard to anything external."[24] The standard example of a man on a train illustrates this point. How do you describe how fast he is going and where he is? Relatively, he can be described as having no motion at all if you and he are sitting in the train; he can be described as moving at 50 miles per hour (MPH) if you observe him from a railway station and at 100 MPH if you observe him from a train moving equally fast on the opposite track, and thousands of miles an hour if you observe him from outside the planet and watch the planet spin on its axis. In a book which discusses the history of time, Peter Coveney and Roger Highfield write that "Newton and many others thought of something akin to an enormous grid stretching across the universe, known as a frame of reference, or a state of absolute rest, to which the motion of all objects in their experiment could be compared. . . . Newton also envisioned an absolute time, independent of space, which flowed at the same rate everywhere. Time was a universal order that existed by and in itself, regardless of what happened in time."[25]

Newton believed that absolute space was unknowable because no observed object could be shown to be at a state of rest compared to other objects. Absolute time could be ascertained by showing the difference between the observed motions of the planets and the paths and speed they should take based on the laws of motion. Absolute rotation of the planets could be determined because it manifests itself in the physical property of centrifugal force. In the end, Newton believed that we could not know if the universe moved in the mystery of the absolute (ultimately, he felt, absolute time and space resided in the mind of God). But Newton also felt that he had shown that the solar system described by Copernicus, Galileo, Kepler, and himself, resided in that world of absolute space and time.[26]

As an idea, Newtonian science meant that the entire universe operated in harmonious order. If that order was not readily apparent, it was the limitations of man and not the lack of order. As described by Hall, Newton's legacy was as follows:

> Nothing happens by chance, nothing is arbitrary, nothing is *sui generis* or law unto itself. The philosophy of both *Principia* and *Optics* insists that however varied, disconnected, and specific the almost infinite range of events in nature may seem to be, it is so in appearance only: for in reality all the phenomena of things and all their properties must be traceable to small set of fundamental laws of nature, and by mathematical reasoning each of them is deducible again from these laws, once they are known.[27]

In the end, all fields of human endeavor adopted the idea of cause and effect—no other method was conceivable. To show why things worked, an experimentally supported hypothesis had to show a cause and effect mechanism. In economics, Adam Smith (1723–1790) postulated supply and demand; in the study of populations, Thomas Robert Malthus (1766–1834) showed that food supply was the determining mechanism; Gregor Johann Mendel (1822–1884) showed how inherited traits affected species development; and in the instance of evolution, Darwin and Spencer showed that natural selection was the mechanism for this phenomenon. This concept of cause and effect, discovered through Newton's scientific method, became the key to unlock virtually all aspects of man's existence.

The products of Newtonian science in the eighteenth century are known as the scientific revolution, the Enlightenment, and the age of reason, but those terms describe different parts of the same phenomenon. But like any movement, be it social or scientific, it succeeded because it found fertile ground in which to grow. In England and France, especially, a rise of the middle class and of commercial interests provided an impetus to overturn the philosophies of the nobility and clergy. According to John Henry Randall, in his history of philosophy *The Career of Philosophy,* a new class of educated people now looked at "a rational order of nature, expressing itself in natural laws, natural rights, a natural religion and natural morality. . . . For them, science was essentially a great liberating idea, an idea that could free men from the past they so much wanted to leave behind." Science meant a secular explanation of life and an alternative to tradition. It meant the emergence of a middle-class culture distinct from the upper class. "This alliance of the middle-class mind with the ideas discerned in the new science was of incalculable significance. It meant that a definite and intellectually imposing expression was given to middle-class ideals, which gained all the prestige accruing from the success of mathematical principles."[28]

Newton's science, like those of our day, was not readily understandable in an undiluted form to the society at large. By 1789, 18 editions of *Principia* had been published. The actual book usually remained unread on the shelves of gentlemen's libraries, but a large number of "translations" for laymen became available. One of the most popular was Count Francesco Algarotti's *Newtonianism for Ladies.*[29] Although the general reader may not have understood the scientific aspects of Newtonian science, they could understand its philosophical importance. The universe described by tradition and by the churches as being ruled by divine intervention was not only antiquated, it was now viewed as inconceivable. In Newton's universe, man controlled his daily events and was watched over by a benevolent but disinterested deity. God had made the universe; it was now up to each man to make his way in it.

Notes

1. While it may now be easy to dismiss the scientific reliability of the Bible, its allure is such that the debate over evolution and special creation still rages. In March 1995 a poll by an

Alabama newspaper noted that more than 60 percent of Alabamians believed that special creation should be taught in science class alongside of the theory of evolution.

2. A. Rupert Hall, *The Rise of Modern Science: From Galileo to Newton, 1630–1720* (New York: Harper & Row, 1963), 38.

3. Robert H. March, *Physics for Poets* (Chicago: Contemporary Books, 1993), 46.

4. A. C. Crombie, *Augustine to Galileo* (Cambridge: Harvard University Press, 1961), 169.

5. Hall, 19.

6. Tycho Brahe constructed huge instruments, to include a 38-foot diameter quadrant that had to be moved by teams of assistants. Later, it was shown that he had managed to get his stellar data accurate down to the limits of human eyesight. The telescope was not discovered until eight years after his death.

7. Marie Boas, *The Rise of Modern Science*, vol. 2, *The Scientific Renaissance, 1450–1630* (New York: Harper & Brothers, 1962), 288–93.

8. Crombie, 189.

9. Hall, 43.

10. Although Galileo did not invent the telescope, he made it substantially better and made a small fortune selling it to Europe's nobility.

11. Peter Coveney and Roger Highfield, *Frontiers of Complexity* (New York: Fawcett Columbine, 1995), 49.

12. Hall, 63.

13. The term *necessary* is a specific scientific usage: that is, it explains the basic nature of an outcome. Other factors such as outside influences and observational limitations do not detract from the understanding of why an event occurs.

14. Galileo's trial makes for fascinating reading. Although he was probably technically innocent of the decree that made it illegal to believe in the Copernican system, he was undoubtedly guilty of violating its intent. Not that it mattered, since the document that was the key evidence against him was almost certainly a forgery.

15. Stephen W. Hawking, *A Brief History of Time: From the Big Bang to Black Holes* (New York: Bantam Books, 1988), 181.

16. Coveney and Highfield, 53.

17. Sir William C. Dampier, *A History of Science and Its Relations with Philosophy and Religion* (Cambridge: Cambridge University Press, 1949), 151.

18. While most of the arguments over the primacy of discoveries were resolved in Newton's favor at the time, one still continues over the creation of calculus which was devised at the same time by both Newton and Leibniz. The Royal Society supported Newton (in a report that he wrote and had signed by a friend), but the form of calculus used today more closely resembles that of Leibniz.

19. Dampier, 150–54.

20. Quoted in Hall, 301.

21. Crombie, 197–98.

22. Jacob Bronowski, *The Common Sense of Science* (Cambridge: Harvard University Press, 1953), 32. Empirical science continued to characterize British science up through the nineteenth century. Some of the experiments could have been taken from Monty Python sketches. Bacon, for example, died of pneumonia after attempting to stuff a duck with snow to check on the preservative qualities of cold. Newton himself spent some nights swinging a bucket of water over his head in the belief he could determine properties of absolute space in the curve the centrifugal force produced in the water.

23. Crombie, 321.

24. John Henry Randall, *Career of Philosophy*, vol. 2, *From the German Enlightenment to the Age of Darwin* (New York: Columbia University Press, 1965), 570.

25. Coveney and Highfield, 63.

26. Hall, 306; and Randall, 591–92.

27. Hall, 303.

28. Randall, 564.

29. Ibid., 571.

Chapter 3

Kant

When I consider Your heavens
the work of Your fingers
the moon and the stars
which You have had ordained
What is man that You are
mindful of him?

—Psalms 8:3–4

This quotation from Psalms ponders the nature of man compared to the universe and God. This same question, “What is man that You are mindful of him?” was asked by the German philosopher Kant. In the eighteenth century, scientists had focused their attention on the physical side of the universe; Kant now focused on the moral nature of man. As for the physical world, however, very few people disagreed that Newton had described the universe and rewritten man’s role in that universe. The predominant view of the Enlightenment, as this period of scientific and social discovery was known, was that the world was established according to certain natural laws and principles. Understanding these laws would allow man to comprehend and predict phenomena. In a sense, the universe was a mystery novel, and the readers were simply trying to solve the puzzle. A French scientist, Pierre-Simon Laplace (1749–1827), stated that if we had perfect knowledge of where every atom was located, it would be possible to predict the future and know the past without error, since each atom moved in accordance with scientific laws. Napoléon who once asked Laplace how he could write a book on the universe and not mention God even once was told, “I have no need of such a concept.”[1] François-Marie Voltaire (1694–1778) stated that “it would be very singular that all nature, all the planets, should obey eternal laws and that there should be some little animal (man), five feet high, who in contempt of these laws, could act as he pleased solely according to his caprice.”[2]

Kant was one of many philosophers who created a philosophy in response to the age of Enlightenment. He is viewed as a synthesis of two earlier philosophies of the Enlightenment, the empirical and the rational. The empirical philosophy was best stated by the Scottish philosopher David Hume (1711–1776), who held that propositions concerning the world and human experience could be validated only by experience or reasoning. The term *reasoning* was specific in that, for something to have been reasoned, it must be shown that if A causes B (some action has created an effect) and that it would have been impossible for B to be present without A, and only A, occurring. It does not mean that A will always produce B or that A and B are tied together (A, in fact, may also cause C). Hume also felt that it was only through the process of experiencing events through our senses we are allowed to know anything. The human mind was simply a repository of these senses; it itself did not have any concepts that were not produced by them.[3]

An opposing philosophical concept, which actually predates the Enlightenment, was that the observed world was an illusion. This was the rational viewpoint, and it was exemplified by the German philosopher and mathematician Gottfried Wilhelm Leibniz (1646–1716). Leibniz, a contemporary of Newton and a noted scientist himself—devised the form of calculus which most closely resembles that which is used today—objected that Newton's universe required no god and ignored man's capacity for free will. He viewed the universe as being comprised of "'monads': nonextended, nonmaterial bearers of energy, engaging in no transactions with one another."[4] While man could know that the universe existed and how it appeared to be structured, what his senses were detecting were only representations of what actually did exist and what God wanted us to see. The human mind translated these monads into concepts and ideas. All knowledge, therefore, only symbolized reality.

In France, the Enlightenment represented a social and political agitation against the ancien régime. In England it stood for a cult of commercial prosperity. By the end of the eighteenth century, both France and England had gone through their social turmoil. In Germany, however, this turmoil occurred late in that century and was a rude awakening from medieval beliefs and values which had existed within the German monarchies. Germany's relatively late arrival into the age of reason produced a different strain of thought: that the nature of man had to be accounted for in any system which intended to describe the universe. This concept is central to the philosophy of Kant and the German Romanticist movement.

Kant was born in Königsberg in April 1724. He was perhaps the most influential philosopher of the nineteenth century, as well as a first-rate scientist and mathematician. His work is generally regarded as a mediation of the philosophical distinctions between Hume and Leibniz; in another sense, however, he was actually debating the contradictions between Newton and the essentials of morality and religion.[5] The crux of this argument, and the implications for military theory, revolves around the answer of a single question: Can empirical reasoning alone allow us to understand the nature of the universe? Randall writes as follows:

> Kant stands with many of his contemporaries as a critic of the inadequacy of the exclusively and narrowly scientific ideal of the Age of Reason, which set up scientific principles and values as the norm to which all else must conform. He is calling them back to experience again; he is insisting on the autonomy of those other and nonscientific areas of human living where truth and demonstration are not the primary values aimed at, although they may be treated and organized by scientific methods—by "reason."[6]

This same argument was to replay itself in the area of military theory between those who were philosophically linked to the Enlightenment and espoused "positive doctrines," and those who felt that war was too complex, too grounded in the nature of man to attempt deterministic formulas.

Studying Kant is a difficult task. As William James "Will" Durant (1885–1981) wrote in *The Story of Philosophy* (1926) when discussing the *Critique of Pure Reason,* "Kant is the last person in the world whom we should read on Kant. Our philosopher is like and unlike Jehovah; he speaks through clouds, but without illumination of the lightning flash. He disdains examples and the concrete; they would have made, he said, the book too long. So abbreviated, it contains some 800 pages."[7]

While generally acknowledged as shaping Western thought in the first half of the nineteenth century, others have found him too obtuse to be rewarding. Russell writes that "Kant deluged the philosophic world with muddle and mystery, from which it is now only beginning to emerge. Kant has the reputation of being the greatest of modern philosophers, but to my mind he was a mere misfortune."[8]

Kant, for better or worse, *did* have an influence on Western thought; and one of those who was under this influence was the military theorist, Clausewitz. Therefore, it is perhaps no surprise that the words applied to Kant's writings by one scholar—"ponderous, laborious to understand, formidable"—can and have been applied to Clausewitz's writings as well. Since the works of both men are noted for their difficulty and complexities, it is possible to show an almost infinite number of influences by Kant on Clausewitz and perhaps impossible to prove any. Even though there is little hard evidence to connect them, there is enough circumstantial evidence to suggest strongly that Clausewitz consciously used Kantian concepts and ideas to describe war. Specifically, Kant's concept of space, time, order, and morality; his concept of absolute versus the "real" world, his system of knowledge, and his concept of genius are all evident in *On War.*

Kant believed that Newton and his predecessors had found the key to understanding the world of appearance. Kant argued that it would be unscientific to believe that there are things beyond the scope of scientific inquiry, but at the same time, there were aspects of the real world that lay beyond the ability of science to understand. One specific aspect that science then (as now) could not totally explain is the creation of the universe. Can God be proven scientifically? What existed in the universe before the universe was there? Can we even imagine a nonspace? Finally, was there time before time began?

The other area unknowable to science was the nature of man. If man had free will and a moral nature, then he was free to choose his actions. But if everything occurs necessarily, does that not preempt free will and man's moral nature? Are there answers to these insoluble dilemmas?

According to Durant, "There is, says Kant, if we remember that space, time, and cause are modes of perception and conception, which must enter into all our experience, since they are the web and structure of experience;

these dilemmas arise from supposing that space, time, and cause are external things independent of perception."[9] "If we take away by degrees," Kant himself wrote in the *Critique of Pure Reason*, "from our perception of a body all that can be referred to mere sensory experience—color, hardness or softness, weight, even impenetrability—the body will then vanish; but the space which it occupied still remains, and this is utterly impossible to annihilate in thought."[10]

This meant that time and space did not exist separately, but were part of man's mechanism for understanding. The concept of order was also something internal to man. These exist a priori. Each person had a different view of the world than other people; our experiences and our intellect shaped what we see. Not only did our knowledge conform to objects, but objects also conformed to our knowledge. In fact, the object may have been different than we could see. Unlike Hume's belief that the human mind was simply a receptacle for sense perception, Kant believed that it was an active organ which molded and coordinated sensation and brought order to experience.[11] In this sense, he merged Hume's belief that each person's knowledge was confined to sensory data and that the process of experience brought order, with Leibniz's concept that the process of observing was active, and that the mind shaped experience.

Kant therefore felt that, like Leibniz, the absolute world, the one which really existed, was almost irrelevant to man. What existed, existed—its nature simply was what it was; with that, we ourselves could have nothing to do. It was, however, equally certain that what existed appeared to human beings in a particular way. But, as Hume believed, our understanding of that universe was driven by our sense organs and if our sense organs had been different, the world would also appear different. A person with color blindness sees a different world than does a person with normal vision. Some migratory birds can apparently sense the earth's magnetic field and their world is, therefore, different from ours. Therefore, the universe as we experience it—the "real world"—is different from the universe that actually exists—the absolute world. That absolute world provides us with a general form from which man can order his experiences with confidence that, generally, his experiences were similar to other men.[12] Kant believed science played a role in man's discovery of his universe and that scientific theory was a product of man's ability to organize experience. Principles of science were necessary because they are ultimately laws of thought that are involved and presupposed in every experience, past, present, and future.

Essentially, Kant said that each person had personal and continuous experience in the world and although there were many people with different experiences, we could make a general assumption that other people had the same general perceptions, otherwise there would be no order in the universe. Every object we perceived, we perceived in context. Therefore, a sense of order and an a priori concept of objects was necessary to undergo human experience. Since man could assume orderliness based on experience, we could frame causal laws and apply them to our experiences. The fact that we could even do this requires that everything we perceived were members of an interacting, single dynamic system.

Kant explained his entire schema of knowledge in three separate works: *Critique of Pure Reason*, *Critique of Practical Reason*, and *Critique of Judgment.* Each one of those works dealt with the three forms of knowledge that Kant felt that man could acquire—understanding, reason, and judgment. He wrote that "the function proscribing laws by means of concepts of nature is discharged by understanding and is theoretical. That of prescribing laws by means of the concept of freedom is discharged by reason and is merely practical."[13] In other words, we could know nature because understanding created our innate sense of order; we "understood" what exists and deduced principles about what we saw. Reason was a process of making decisions based on our innate sense of morality and free will.

In between these two types of knowledge was judgment, which was the process of interpreting our sense experiences through our ability to apply order and recall past experience to a particular instance. He further divided judgment into two subcategories.

The first was determinate judgment where a person applied a concept, held in advance, to a particular instance. For example, if we had a concept of "greenness," we could judge something as being green when it was encountered. The other form, reflective judgment, occurred when we encountered a phenomenon and created a concept that explained it. This concept was the invention of the thinker himself.[14]

Kant suggested that aesthetic pleasure was an outcome of reflective judgment both to the successful theorist (the one whose mind "created" the concept that applies to a phenomenon) and to those who were merely spectators. "Just as if it were a lucky chance that favored us, we are rejoiced where we meet with such systematic unity under merely empirical laws."[15] Essentially, Kant felt that there was satisfaction when one was able to comprehend order in something which was before unknown.

Kant also tied this pleasure to an understanding of beauty and art. It was impossible to prove through empirical laws (reason alone) what was beautiful and what was not. If something gave a person no aesthetic satisfaction, it would be impossible to prove to him that an object was, in fact, beautiful. The appreciation of beauty was an exercise of understanding (comprehending order in nature) and a person's imagination which formed a type of reflective judgment. On one hand, a person's imagination was clearly his own, but the ability to comprehend order in an art object or a phenomenon was due to the inherent order in the universe; so, this order was properly recognized by others. (This allowed us to view a piece of art, or any other human endeavor, and to understand and appreciate its qualities without considering it actually beautiful.) This interplay of imagination and understanding produced a special type of reflective judgment known as genius, which was bound by the order of nature but not by any special rules because no method was available to prove or disprove the work of genius. Kant also implied that this concept of genius not only applied to artist but to theorists of any human endeavor as well.[16]

> We thus see (1) that genius is a talent for producing that for which no definite rule can be given; it is not mere aptitude for what can be learned by rule. Hence originality must be its first property. (2) But since it also can produce original nonsense, its products must be models, i.e. exemplary, and they consequently ought not to spring from imitation, but must serve as a standard or rule for judgment for others. (3) It cannot describe or indicate scientifically how it brings about its products, but it gives the rule just as nature does.[17]

Kant and the German Romantic movement were a response to the Enlightenment which had been the dominant cultural framework throughout the eighteenth century. While he believed the scientific method was a way—indeed, the only way—to understand the physical aspects of the universe, this method did not take into account the nature of man himself. In the relationship of man and the universe, Kant argued that man possessed certain concepts a priori: time, space, and order. The fact that he exercised free will showed that the course of the universe was not predetermined and that there were aspects of it which science could not deduce from empirical data. The universe had to be examined in its two coexisting realms: the moral and the physical. Finally, he showed that based on man's free will and individual senses, not all phenomena of nature could be judged by any method of proof, but that some phenomena could be viewed as part of man's common experiences. It was therefore possible to deduce certain general guidelines about that phenomena. Through his ability to understand, reason, and, most importantly, judge (the highest form of which was genius) was man able to learn.

Notes

1. Sir William C. Dampier, *A History of Science and Its Relations with Philosophy and Religion* (Cambridge: Cambridge University Press, 1949), 181.
2. Ibid., 197.
3. D. J. O'Connor, *A Critical History of Western Philosophy* (New York: Free Press of Glencoe, 1964), 299.
4. Ibid.
5. Ibid., 297.
6. John Henry Randall, *Career of Philosophy*, vol. 2, *From the German Enlightenment to the Age of Darwin* (New York: Columbia University Press, 1965), 109.
7. Will Durant, *The Story of Philosophy: The Lives and Opinions of the Greater Philosophers* (New York: Simon & Schuster, 1926), 277.
8. Dampier, 195. Dampier quotes Russell's *An Outline of Philosophy,* London, 1927, 83.
9. Durant, 288.
10. Immanuel Kant, *Critique of Pure Reason*, ed. Norman Kemp Smith (New York: Saint Martin's Press, 1965), 426.
11. Durant, 291.
12. O'Connor, 300.
13. Ibid., 313.
14. Ibid., 314.
15. Ibid.
16. Ibid., 314–15.
17. Immanuel Kant, *The Critique of Judgment*, trans. J. H. Bernard (New York: Hafner Publishing Co., 1951), 150–51.

Chapter 4

Clausewitz

In 1991 Alan Beyerchen wrote a well-received article in *International Security* titled "Clausewitz, Nonlinearity, and the Unpredictability of War." Beyerchen postulates that Clausewitz viewed war as a nonlinear phenomenon and that he described it in terms which mirror today's complexity theories.[1] Although that idea is largely correct, the article pays little attention to why Clausewitz viewed war in terms that we now call nonlinear. Clausewitz clearly felt that the Newtonian scientific method of investigation applied to war; it was the nature of man that produced some of the uncertainties of war, but that same nature also produced a method—genius—to bring order to the phenomenon. Clausewitz, like all educated men of his time, was a devotee of Newton; like many Germans of his time, he was also a devotee of the German Romantic movement embodied in Kant. It will, therefore, be useful to show what philosophical concepts were operating in Clausewitz's theory of war, as well as what scientific frameworks and metaphors he derived from Newtonian science.

Azar Gat showed that just as the age of Enlightenment brought about a flurry of intellectual activity in science, art, and literature, there was a sharp increase in the study of military theory as well. Referring to a bibliographical study of military works in France, he also showed that in the middle of that century, approximately 100 military works were published in the years between the Seven Years War and the French Revolution, more so than any time before that period or afterward throughout the nineteenth century. Writers such as De Saxe, Puysegur, von Bülow, and Lloyd were all caught up in the spirit of the age.[2] Gat argued that these authors were affected by the same influences as the scientists, artists, and nonmilitary writers of the time.

> The ideal of Newtonian science excited the military thinkers of the Enlightenment and gave rise to an ever-present yearning to infuse the study of war with the maximum mathematical precision and certainty possible. . . . Indeed, the military thinkers of the Enlightenment maintained that the art of war was also susceptible to the systematic formulation, based on rules and principles of universal validity which had been revealed in the campaigns of the great military leaders of history.[3]

Even as they were developing their theories, however, the tide was turning away from the determinism of the eighteenth century. Michael Howard observes that "this search for scientific certainty in military affairs was taking place at a time when thinkers concerned with other areas of human activity were beginning to question the whole idea of scientific certainty."[4]

There can be little doubt that Kant had an influence on Clausewitz and *On War*, but there is no evidence that Clausewitz ever actually read any of Kant's works. Most historians believe that Clausewitz got his Kant second and third hand. In *Clausewitz and the State*, Peter Paret writes as follows:

> The philosophic strain, which was so powerful in him, is of a singular, practical kind. He frequently used concepts learned from other writers, together with ideas that were the common property of his generation. Both in method and in terminology, he was influenced by the philosophers of the Enlightenment and of German idealism. . . . Such thinkers as Kant, Herder, and Fichte inspired him not only directly through their works but also through the filter of German historical writings that was influenced by them.[5]

Gat believes that, at a minimum, Clausewitz's association with Gerhard Johann David von Scharnhorst would have exposed Clausewitz to Kantian philosophy.[6]

Paret also states that Clausewitz, like other Germans of his class, attended lectures on logic, ethics, and science as well as reading nonprofessional articles on philosophy. It is certain that Clausewitz attended the lectures of J. G. Kiesewetter, who popularized Kant, since notes on one such lecture were found in the Clausewitz family archives.[7] Clausewitz was shaped by the philosophy of German idealism of the late eighteenth and early nineteenth centuries, and the most influential philosopher at that time was Kant. Without being able to show exactly how much science and philosophy Clausewitz acquired, or how he acquired it, it is perhaps easier to examine what he knew about these subjects as shown in his writings and then trace their genealogy back to their creators, be they immediate or several times removed, from his intellectual world.

Clausewitz's affinity for science is revealed in three ways throughout the length of *On War*: the use of scientific metaphors; the use of a scientific framework for investigation; and the use of concepts he derived from science and adapted to military theory. The first of these, metaphors, are the most readily apparent since they are used to illustrate some of Clausewitz's main themes. Of his trinity of the people, the army, and the government he writes, "Our task . . . is to develop a theory that maintains a balance between these three tendencies, like an object suspended between three magnets."[8] Other such references to scientific phenomena appear such as fulcrums, pendulums, polarity, electricity ("what exactly is this nonconducting medium, this barrier that prevents a full discharge?")[9] and, of course, friction and center of gravity. Throughout the book, indirect references to Newton's laws of motion were used both as a concept and as a metaphor to describe the interaction between armies. An example:

> When this movement has been exhausted, either through the difficulties it has met, such as the friction that are inherent in any action, or through new opposing forces, inactivity returns, or a new cycle of tension and decision begins, followed by further movement—usually in the opposite direction. This theoretical distinction between balance, tension, and movement has a greater practical application than may at first appear. . . . A state of rest and equilibrium can accommodate a good deal of activity.[10]

Considering Clausewitz's intended audience (men with the same background and education as himself), these metaphors were useful since they quickly described the nature of the concepts he was attempting to show. They went beyond mere superficial similarities to describe the action taking place. In that Newton's laws of motion and Newtonian science were used throughout the eighteenth century (and the nineteenth century as will be shown in the next chapter) to describe all forms of human endeavor, the use of these metaphors were appropriate. What Clausewitz was describing, after all, was the use of force and, within the framework of the time, the laws of force applied to the phenomenon of war as they did to the solar system.

In explaining one of the purposes for writing *On War,* Clausewitz wrote that "part of the object of this book is to examine whether a conflict of living forces as it develops and is resolved in war remains subject to general laws, and whether these can provide a useful guide to action. This much is clear: this subject, like any other that does not surpass man's intellectual capacity, can be elucidated by an inquiring mind, and its internal structure can to some degree be revealed. That alone is enough to turn the concept of theory into reality."[11]

Like many of his contemporaries, he believed that the conduct of war had developed in accordance with its natural laws.[12] His aim, therefore, was to investigate the phenomenon and deduce the composition of these laws. The process in which he does this is in accordance with Newton's description of the scientific method: observe the phenomena, make the phenomena intelligent by fitting them into a coherent system, and then verify the hypothesis through testing.

Clausewitz starts this process from the first page of *On War*: "I propose to consider the various *elements* of the subject, next its *various parts* or *sections*, and finally the *whole* in its internal structure."[13] He first made a general statement of the nature of war which is really his unifying vision of the phenomenon: *War is thus an act of force to do our will*. He proceeds to observe this phenomenon and places it into increasingly larger components. The final aspect of Newton's method of scientific investigation, testing the hypotheses, is conducted through the use of history. "In the study of means, the critic must naturally frequently refer to military history, for in the art of war experience counts more than any amount of abstract truths."[14] And "historical examples clarify everything and also provide the best kind of proof in the empirical sciences."[15] His description of the phenomena, his theories, and his testing are interwoven throughout the book, but in the end he has accomplished each of these steps. Clausewitz's insistence that theory be tested by reality is faithful to Newton's insistence that theory without empirical testing is worthless. Also, faithful to Newton's view of science was the belief that theory must be universal and simple.

"All things in war are simple," Clausewitz wrote. Throughout *On War*, he shows that military theory should be as uncomplicated as possible; in fact, for any military theory to describe the phenomenon of war, it had to be simple for once it strayed from the basic factors inherent in war, it would soon become too complicated to be applied to anything but specific conditions. Like Newton before him and Albert Einstein (1879–1955) a hundred years later, Clausewitz sought to explain a phenomenon in principles that were universal. Rather than a Ptolemaic model of war in which different parts of the phenomena were governed by separate laws, his goal was Newtonian in that he sought to describe the nature of war as operating by one simple mechanism. The development of universal principles and rules was good, natural, and in accordance with the scientific laws of reason; what could not be done, however, was to construct an algebraic formula for use on the battlefield.[16] For general principles and rules of war to maintain their universality, they could not seek, to use his term, *positive doctrine.*

There were, of course, some military theorists, Jomini and De Saxe for example, who did seek such positive doctrines. Clausewitz took issue with Jomini's use of transitory phenomena as a basis for a theory of war rather than those things which are constant. Paret writes that "Clausewitz objected that Jomini's principles would lose the absolute validity claimed for them if it could be shown that earlier generations had good reason to ignore them. Not that Jomini 'stated anything wholly wrong, but often he presented the incidental as the essential.'"[17]

While Clausewitz used scientific metaphors to facilitate his description of war and the scientific method for investigating the phenomena, the most important scientific influences on him were the concepts he derived from his education. The first of these concepts, force, has already been briefly described. Clausewitz clearly defined the act of war as the application of force and that this force was subject to the same factors as the force described in Newton's laws of motion: mass, inertia, momentum, resistance, and friction.

This description of force and how it acted on the entire universe was the unifying theme in Newtonian science; so too was it in Clausewitz's theory of war. For Newton, this force was gravity and it, as has been shown, tied the affairs of the earth to those of the stars. For Clausewitz, this force was violence used for the purposes of the state and it was the unifying theme throughout *On War*. "But war . . . must contain some more general—indeed, a universal—element with which every theorist ought above all to be concerned. The age in which this postulate, this universally valid element, was at its strongest was the most recent one [the Napoleaonic wars] when war attained the absolute in violence."[18] Essentially, the book described the use of force under different conditions and at different levels. It showed what factors inhibit the use of force and keep real war from being absolute war—absolute war being the unrestricted application of force.

The concept of friction is related to the concept of force, for it is one of the factors which kept the application of force from being total since it led to imperfect knowledge of the battlefield. Friction was everywhere and in the reoccurring metaphors of mass, motion, and machines, it was an inhibition on force which could not be predicted. "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."[19] Several times in

On War, Clausewitz described the antidote for friction in warfare as being the same as it was in mechanics: force, both physical and mental. Large amounts of force could overcome friction, but it wears down the machine as well.

Clausewitz's use of the concept of absolute war was similar to Galileo's creation of the ideal state of a vacuum when he described the acceleration of falling bodies. "In the absolute form of war, where everything results from *necessary causes* and one action rapidly affects another, there is, if we may use the phrase, no intervening neutral void" (emphasis added).[20] The phrase recalls Galileo's work in two ways. First, the term *necessary causes* was a scientific usage for the force or mechanism being described regardless of interfering factors (i.e., friction). In Galileo's description of falling bodies, the necessary mechanism was the formula for acceleration of falling bodies; the "intervening neutral void" was the earth's atmosphere.[21]

Like Galileo and Newton, Clausewitz felt the need to postulate an absolute form of the phenomenon he was investigating as a fixed reference point in order to allow him to describe real war. Real war was too problematic a phenomenon to be used to describe war's essence or its *necessary* elements.

> It follows that war is dependent on the interplay of possibilities and probabilities, of good and bad luck, conditions in which strictly logical reasoning often plays no part at all and is always apt to be a most unsuitable and awkward intellectual tool. It follows, too, that war can be a matter of degree.
>
> Theory must concede all this; but it has the duty to give priority to the absolute form of war and to make that form a general point of reference, so that he who wants to learn from theory becomes accustomed to keeping that point in view constantly, to measuring all his hopes and fears by it, and to approximating it *when he can* or *when he must* (emphasis in original).[22]

Clausewitz also, like Galileo and Newton, used the concepts of absolute and real war as a tool to describe those elements which separate them: friction, chance, and uncertainty. Recalling an earlier description of Galileo's use of an ideal state, "only through idealism can the reality explaining the complexities and discrepancies be discerned."[23]

In understanding those things which separate real from absolute war, Clausewitz had to look somewhere other than science since much of what caused this difference was due to the nature of man: our moral qualities. With only slightly veiled reference to the theories of Jomini and von Bülow, Clausewitz wrote that "it is even more ridiculous when we consider that these very critics usually exclude all moral qualities from strategic theory, and only examine material factors. They reduce everything to a few mathematical formulas of equilibrium and superiority, of time and space, limited by a few angles and lines. If that were really all, it would hardly provide a scientific problem for a schoolboy."[24] Because the nature of war was so dependent on man's moral nature, it was necessary for Clausewitz to describe this nature and for that he turned to philosophy.

The most pervasive Kantian concept in *On War* is that the universe (and, therefore, war) had to be described in both the physical and moral domains. Kant's philosophy helped to describe the moral aspects of the universe just as

Newton's helped to describe the physical. More importantly, since it was man's moral domain that most often produced uncertainties about the physical aspect of war, it was what made war very difficult and problematic.

Clausewitz believed that although it was "idiotic" to create hard and fast rules concerning warfare or to postulate principles of war that did not take into account man's moral attributes, he did feel that general statements and principles could be made about war. Like Kant, Clausewitz used the concept of an absolute state to provide general form to our ideas about the real world. These general forms produced a common sensory experience which allowed such general principles to be universally applicable. From these general forms, man's internal sense of order could combine and synthesize experiences to create a vision or theory to explain war. Order was something that man brings to his study of war.

> Theory should cast a steady light on all phenomena. . . . It should show how one thing is related to another, and keep the important and unimportant separate. If concepts combine of their own accord to form that nucleus of truth that we call a principle, if they spontaneously compose a pattern that becomes a rule, it is the task of the theorist to make this clear. Any insights gained and garnered by the mind in its wanderings among basic concepts are benefits that theory can provide.[25]

The general forms of absolute war and man's concept of order that is part of perception, then create a single dynamic view of the phenomenon of war.

As has been shown, Kant described three forms of attaining knowledge: understanding, judgment, and reason. Clausewitz never consistently utilized either the concept or the term *understanding*, which Kant had defined as prescribing laws by means of the concepts of nature. Clausewitz, however, used the word *reason* consistently with Kant's philosophy; and although the ability to gain information through a deductive process was important, it was sometimes presented as something stodgy and ordinary.

It was the process of judgment that Clausewitz clearly felt was the most important quality of a leader. Kant described judgment as the process of interpreting perceived conditions and applying order to new situations. Clausewitz showed that this method of acquiring knowledge was essential because friction, chance, and uncertainty produced situations that differ greatly from past events and continue to change rapidly. Although Kant's determinate judgment, which was the ability to apply known concepts and principles to a situation, was also important (and one of the reason's a study of history and personal experience was an aid to a commander), the type of knowledge produced by *reflective* judgment was what Clausewitz felt made great leaders. New situations and "unique cases" must be left to judgment and talent.[26] Clausewitz's concept of coup d'oeil is a type of rapid reflective judgment. "The concept," Clausewitz wrote, "merely refers to the quick recognition of the truth that the mind would ordinarily miss or would perceive only after long study and reflection."[27]

Clausewitz, like Kant, also believed that the successful application of judgment produced an aesthetic pleasure. Kant had written that this pleasure comes from the act of creation of a new concept that applied to a new set of sensory observations or it could occur in appreciation of another's creation. In keeping with this, Clausewitz argued that by analyzing campaigns of the past "it is obvious that the intellectual pleasure at success and the intellectual discomfort at failure arise from an obscure sense of some delicate link, invisible to the mind's eye, between success and the commander's genius. It is a gratifying assumption."[28]

Kant had connected reflective judgment, and his concept of beauty to his concept of genius, which he felt was the highest form of reflective judgment. Clausewitz did so as well. "Beauty," he wrote, "cannot be defined by abscissas and ordinates; neither are circles and ellipses created by their algebraic formulas." He used this analogy to show that it is man's judgment, developed through reflection, which hits on the right course.[29]

Clausewitz further mirrors Kant in his description of genius. First, genius operates outside of preexisting rules. "Whenever [a commander] has to fall back on his innate talent, he will find himself outside the model and in conflict with it . . . *talent and genius operate outside the rules*" (emphasis in original).[30] Kant's last two statements on genius were that it must produce not only original works but they must be exemplary and eventually become the rule by which other similar works are tested. In the same vein, Clausewitz wrote of the products of genius that "if, in warfare, a certain means turns out to be highly effective, it will be used again; it will be copied by others and become fashionable; and so . . . it passes into general use and is included in theory."[31]

Paret wrote that Clausewitz frequently used concepts that were common to the property of his generation. Faced with the daunting task of describing the true nature of war, Clausewitz used the tools available in his time. Familiar with science, he used those concepts, metaphors, and the scientific method of inquiry to describe the phenomenon. These gave him a convenient "shorthand" to communicate his ideas to his generation and were especially appropriate in describing the physical aspects of war.

War, however, is fought not only in the physical realm but the moral realm as well. Clausewitz, who had witnessed firsthand the turmoil produced by the Napoleonic conflicts, had to also describe the fear, courage, and uncertainty that Newtonian science and the Enlightenment philosophies were poorly equipped to illuminate. For this he turned to another readily available tool, the philosophy of the German Romantic movement. By combining one framework that was best able to describe the physical aspects of war with another framework that was best able to describe the moral aspects of war based on the nature of man, he was able to describe what he felt was the true nature of the phenomenon of war.

Notes

1. Alan Beyerchen, "Clausewitz, Nonlinearity, and the Unpredictability of War," *International Security* 17, no. 3 (Winter 1992/1993): 59–90. To be fair, Beyerchen does not claim

that Clausewitz knowingly predicted complexity theory but that he understood the uncertainty that mutually adaptive systems (i.e., armies) produce.

2. Azar Gat, *The Origins of Military Thought from the Enlightenment to Clausewitz* (Oxford: Oxford University Press, 1989), 25.

3. Ibid., 29.

4. Michael Howard, *Clausewitz* (Oxford: Oxford University Press, 1983), 13.

5. Peter Paret, *Clausewitz and the State* (Oxford: Oxford University Press, 1976), 84.

6. Gat, 162.

7. Raymond Aron, *Clausewitz, Philosopher of War*, trans. Christine Booker and Norman Stone (Englewood Cliffs, N.J.: Prentice-Hall, 1985), 224.

8. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, N.J.: Princeton University Press, 1976), 89.

9. Ibid., 579.

10. Ibid., 221.

11. Ibid., 149–50.

12. Ibid., 186.

13. Ibid., 75.

14. Ibid., 164.

15. Ibid., 170.

16. Ibid., 141.

17. Paret, 153.

18. Clausewitz, 593.

19. Ibid., 120.

20. Ibid., 582.

21. I recognize here that this attribution of the term *necessary causes* to a scientific concept is tenuous at best. While the phrase would suggest this scientific connection, the original German text may not support it.

22. Clausewitz, 580–81.

23. A. Rupert Hall, *The Rise of Modern Science: From Galileo to Newton*, 1630–1720 (New York: Harper & Row, 1963).

24. Clausewitz, 178.

25. Ibid., 578.

26. Ibid., 139.

27. Ibid., 102.

28. Ibid., 167.

29. Ibid., 213.

30. Ibid., 140.

31. Ibid., 171.

Chapter 5

Spencer and Fuller

In the study of war the military student will find that some knowledge of philosophy is of the greatest assistance.

—J. F. C. Fuller

The *Origin of the Species*, published in 1859, is one of the major milestones in Western civilization. In this book, British naturalist Darwin postulated that all living organisms had evolved from lower life forms through the process of natural selection. Darwin was not the first person to consider evolution: Kant had written of the possibility that man evolved from apes; Erasmus Darwin (Charles's grandfather) and Chevalier de Lamarck had said that species develop from simpler forms through the inherited effects of use and disuse.[1] Darwin's discovery of the role that natural selection had in the process of evolution—which was the truly original aspect of *Origin of the Species*—was made independently but at the same time as another British naturalist, Alfred R. Wallace. Darwin published his findings prior to Wallace, and the term *Darwinism* has become synonymous with evolution.[2]

The philosophical aspects of this theory, however, had as great an influence as the scientific aspects. In *A History of English Philosophy to 1900*, William Ritchie Sorley wrote that Darwin's work had the same effect upon society that Copernicus's work had three centuries earlier: that it was, to use the ironically appropriate term, *revolutionary*.[3] Darwin's work was the summit of a century's exploration in biology. As math excited the minds of the educated man in the seventeenth century and physics in the eighteenth century, biology became the flagship science in the nineteenth century.[4] It was largely the theory of evolution, combined with the keen interest in biology, that caused biological concepts to gain predominance over other sciences in their philosophical importance. Its major influence on society was the social Darwinist philosophy which held that individuals, countries, and whole races evolved through competition and war, and that only those best adapted to the environment would thrive. Even though the system of belief that shaped society bore his name, Darwin never actually discussed the philosophical aspects of his findings. That was done largely by a philosopher of whom Darwin once said, "I suspect that hereafter he will be looked at as by far the greatest living philosopher in England; perhaps equal to any that have lived."[5] That philosopher was Spencer.

Herbert Spencer

Spencer was born in the English Midlands in 1820. The eldest of nine, and the only child to survive infancy, his family was staunch dissenters who valued religious liberty, individuality, and social equality. Although (or perhaps because) his father was a schoolmaster, Spencer was taught at home and never attended a university. At the age of 17, he started working for a railroad and learned civil engineering. While he was learning his new trade, he acquired an interest in biology, as did many others of his class. Applying his background in engineering to biology, he noted that while the mass of a living creature increases as the cube of its dimensions, the strength of its bone structure increases only as a square of those dimensions. This relationship is now considered a basic concept in biology.[6] If Spencer cannot be considered to have been a scientist, it is acknowledged that his understanding of science was deep and far-reaching.

In 1843 at the age of 23, Spencer started his second career as a writer and social commentator and became a subeditor for the *Economist*. In the 1840s, most of his writing dealt with political issues, but during that time he continued to pursue his strong interest in biology both through reading and by attending lectures. In 1852 seven years before Darwin published *Origin of the Species,* Spencer published “The Developmental Hypothesis” in the *Leader* which openly rejected special creation and advocated organic evolution as the best explanation for the origin of the various species.[7] Throughout the 1850s, Spencer slowly pieced together his theory of evolution.

It was Spencer, in fact, who made current the term *evolution* rather than the older, purely biological term *epigenesis*, based on his desire to describe a general process that was not limited to biology.[8] This notion was first formulated in 1857 in his article “Progress: Its Law and Cause.”

> The advance from the simple to the complex, through a process of successive differentiations, is seen alike in the earliest changes which we can inductively establish; it is seen in the geologic and climatic evolution of the Earth, and of every single organism on its surface; it is seen in the evolution of Humanity, whether contemplated in the civilized individual, or in the aggregation of races; it is seen in the evolution of Society in respect alike of its political, its religious, and its economical organization; and it is seen in the evolution of all . . . [the] endless concrete and abstract products of human activity.[9]

This early description of the process of evolution shows that Spencer attempted to show a unifying mechanism that explained the universe. He could not, however, show exactly why evolution worked. He had thought, like Lamarck, that it was inherited traits based on the “use or disuse” of organs that caused this progression. When Darwin published *Origin of the Species* in 1859, Spencer found that it provided strong support for his theory and, more importantly, a mechanism that showed why it worked, natural selection. What was best, survived; what survived grew more distinct and specialized and thrived in its environment. The phrase used to describe this process, “survival of the fittest,” was coined by Spencer.[10]

In 1862 he wrote the first book of a five-book set called *Synthetic Philosophy.* This initial work, *First Principles,* was the foundation of social Darwinism. It is unlikely that many people read more than *First Principles*; Spencer's writing style is intricate and ponderous. He wrote more 80,000 pages in his writing career, but it was the 500 pages of *First Principles* that the English upper middle class (and their American counterparts) read and absorbed.

In *First Principles,* Spencer started his 30-year quest to provide a unifying vision of the universe. That unifying mechanism was the process of evolution, derived from the laws of motion. Evolution, however, was much more than "survival of the fittest." Survival of the fittest is *why* evolution works. Evolution was "an integration of matter and a concomitant dissipation of motion; during which the matter passes from an indefinite, incoherent homogeneity to a definite, coherent heterogeneity; and during which the retained motion undergoes a parallel transformation."[11]

Just as Newton's laws applied to everything from the rotation of planets to the fall of apples, Spencer showed that evolution unified all aspects of existence and, therefore, applied across all sciences and social sciences. Planets had evolved from stellar nebulae, the human organs had evolved from the embryo, knowledge had evolved from the unification of sensations and memories, and states had grown from homogeneous masses.[12]

Contrary to popular understanding of evolution, evolution works *both* ways. It is possible, in fact it is necessary, that things *devolve.* Another definition (Spencer's definition also "evolved" over the years) was that evolution was "the change from a dispersed, imperceptible state to a concentrated, perceptible state, is an integration of matter and concomitant dissipation of motion; and the change from a concentrated, perceptible state to a dispersed imperceptible state, is an absorption of motion and concomitant disintegration of matter. . . . When taken together, the two opposite processes thus formulated constitute the history of every *sensible* experience under its simplest form."[13]

Spencer used the term *sensible* in a specific manner to mean that all information is derived from the senses, similar to Hume's concept of knowledge. Like Hume, Spencer believed that what actually existed—the absolute—was impossible to perceive except through the manifestation of force. Matter was something in coexistent positions that offered resistance to force. Space was coexistent positions that offered no resistance to force, and motion was a series of positions occupied by matter in succession and within the framework of time. "The experiences out of which, during the evolution of intelligence, this abstract of all co-existences has been generated, are experiences of individual positions ascertained by touch; and each of such experiences involves the resistance of an object touched, and the muscular tensions which measure this resistance . . . the experiences from which the consciousness of Space arises are experiences of *force.*"[14]

Force, he said, was the "ultimate of ultimates." Although the perception of space, time, matter, and motion were the composition of human intelligence—all of these were built up or abstracted from experiences of force. Force existed separate from human senses but in what form and matter was impossible to tell; it was an absolute, as was absolute space and time which he uses in a fashion similar to Newton. Space and time were fixed reference points, themselves unknowable except by relative conditions between two objects. ("All we can assert is that Space is a relative reality; that our consciousness of this unchanging relative reality implies an absolute reality equally unchanging in so far as we are concerned.")[15]

Tied to Spencer's absolute universe were the concepts of the Ultimate Religious and Ultimate Scientific ideas.[16] These ultimate ideas were inexplicable or unknowable aspects of the universe; like many philosophers and scientists before him, Spencer used the creation of the universe to explain these ideas. The Ultimate Religious idea was that of the First Cause: something outside the realm of the universe had to have created it and have been self-existent for eternity, otherwise, what created the entity which created the universe? Space and time were Ultimate Scientific ideas that were demonstrated in the same fashion.

Spencer acknowledged that these were things that could never be understood. At the same time, however, there were many things that science could reveal and this would be done through the evolution of ideas. Those ideas that were valid would survive, or perhaps evolve in conjunction with other ideas. Those ideas that were no longer useful or valid would be forgotten. As science revealed more of the universe, the Ultimate Religious ideas would also be reduced to the core of unknowability, which was God. (Spencer wrote that a god understood is no god at all.)

As for the process of natural selection, Spencer showed that it was the product of force as well, both among competing entities and the *cause* of competing entities. It was force that changed homogeneous masses into differentiated groups. As a basic example, Spencer described a body of water totally at rest. As the Sun shined on the water, it produced heat differentials and currents. As these elements (and those creatures that lived in the water) reacted to the environment, and then against each other, those which were best adapted to that environment would emerge as the dominant form. Because all entities were subject to the laws of motion and the laws of force, Spencer believed that free will did not truly exist but is only perceived by men: man's actions, in fact, followed the path of least resistance.

Although Spencer did not glorify war (he was a vocal opponent of Britain's role in the Boer War), he wrote that war was the prime mechanism of evolution among societies. Those societies that could effectively fight wars survived and flourished while those that could not dwindled and disappeared. The ability to wage war also affected the social, political, economic, and even religious organs of each society.[17]

Spencer wrote that "for every society, and for each stage in its evolution, there is an appropriate mode of feeling and thinking."[18] This was true of Spencer's philosophy itself. It arrived during the latter half of the industrial revolution, and it was the philosophy that explained and justified the world of the industrialist and the middle class. *Competition* was the final arbiter of what was right. This meant that the individual should be free to seek his own way and that the state should not interfere except to enforce contracts. To members of the middle class, Spencer's philosophy connected nicely with the ideal of the "self-made man": that they could go as far as their talent and effort took them. Also, it supported the industrialists' increasing interest in international markets and colonization. Not to try to dominate was to prove unfitness. Overseas expansion was shrouded in the noble ideals of bringing civilization and Christianity to lesser races.[19]

In the end, Spencer attempted to fulfill what he felt was philosophy's role in civilization: the integration of man's knowledge into a single, unified system. One general text of English philosophy describes this process. "The desire for system and his remarkable capacity for it dominated everything. Unceasingly he abstracted, classified, generalized, deduced, moving forward to more and more abstract unifications, until he had reached the point where he could sum up the universe in a single formula. The result was a system in which everything was given its place, a system so boldly planned and so skillfully and neatly ordered that, whatever our ultimate attitude towards it may be, we cannot help admiring it."[20]

Although the words are written about Spencer, they would apply equally well to Fuller and his book, *The Foundations of the Science of War.*

J. F. C. Fuller

Fuller was born in 1878, the son of an Anglican cleric. Unimpressive in childhood, he took little interest in schoolwork up through, and including, his time at the Royal Military College. Although his formal education was more extensive than Spencer's, in the areas of science and philosophy he was largely self-taught. Unlike most of his fellow subalterns, Fuller devoted most of his private time to reading and studying. In *J. F. C. Fuller: Military Thinker*, Brian Holden Reid describes the wide range of books and people who shaped Fuller's thoughts to include Spencer's *First Principles* which Fuller read in 1905. Reid believes that "Fuller's interest in evolutionism shaped Fuller's intellectual outlook more than anything else."[21]

There can be no doubt that Spencer influenced Fuller as noted when Fuller quotes Spencer extensively and writes "as Spencer is the philosopher with whom I am best acquainted—a philosopher who has attempted to work out a synthesis which embraces all sciences—I intend to make him my master and my guide."[22] In such cases where there is not only a smoking gun but a blood trail of citations, it is easy to show Spencer's influence on Fuller. The most important section of *The Foundations of the Science of War,* the "Law of Economy of Force," provides Fuller's single, overarching principle of war and is derived completely from *First Principles,* and here Fuller acknowledges Spencer's philosophy. But even when Fuller does not cite Spencer, there are several other key areas of Fuller's book that Spencer's influence is clearly evident. Spencer's philosophy provided Fuller with a framework on which to construct his military theory. Spencer's concept of force, knowledge, and order also can be shown to have had a direct influence of Fuller's theory. On top of Spencer's philosophy came the influence of the social Darwinist movement that, by the time Fuller became acquainted with it, had evolved in ways that Spencer (who died in 1903) would not have totally approved.

Fuller wrote *The Foundations of the Science of War* and an earlier work, *The Reformation of War*, in response to what he saw as the failure of military theory in the First World War. Just as Clausewitz had been confronted with a new reality of war after Napoléon, so too was Fuller confronted with a new reality after the carnage of the Great War. Conscious of the similarity, in *The Reformation of War* he wrote, "Today we stand at the parting of the ways, behind us lingers an old-world conception rooted in the events symbolized by '1815.' In front of us is cast the shadow of a new era which, in its time, will be symbolized by '1918.' Both were conceived in peace, both were born in war."[23]

Fuller also wrote that World War I was the result of the practices of witch doctors and alchemists. He called alchemy "art without science" and "a false classification of real facts." Essentially, Fuller felt that prewar military theory, like the Ptolemaic solar system, had provided an explanation of the observed phenomenon without providing reason or cause. Fuller called for a scientific examination of war that provided true classification of facts and used a true scientific method.[24]

This method was provided by Spencer's philosophy. As noted previously, Spencer "abstracted, classified, generalized, deduced, moving forward to more and more abstract unifications, until he had reached the point where he could sum up the universe in a single formula." *The Foundations of the Science of War* followed the same, sometimes complicated path, made even more complicated by Fuller's adherence to his threefold order of the universe.

Spencer's vision of an orderly, deterministic universe provided a stable philosophical and scientific base from which theories could be constructed. The fact that the universe was ruled by the laws of evolution (which were derived from the laws of motion and the properties of force) allowed Fuller to think of war as being a science. "If war is a science, or is reduced to a science, as a consequence such laws, principles, and rules are axiomatic, for science lays bare the nature of relationships and discovers the reasons upon which they are based. There must be, therefore, certain laws or principles of war, just as there are laws of chemistry, of physics, and of psychology."[25]

And Fuller felt that these laws could be timeless since the nature of the universe is unchanging: "Truth is Truth," he wrote, "and the Truth of yesterday is the Truth of today and the Truth of today is the Truth of tomorrow."[26]

In Fuller's chapter on "The Law of Economy of Force," he quotes from Spencer's *First Principles* at length. The unifying mechanism was force—again, "ultimate of ultimates." If evolution was the framework upon which the universe operated and the mechanism for evolution was natural selection, it was force that drove the entire process. Force, Spencer had showed, cannot be created or destroyed; matter was indestructible and motion was continuous and rhythmic. Through this process all entities constantly went through transformations between states categorized by degrees of homogeneity and heterogeneity. Therefore, the law we sought, according to Fuller, was the law of "*continuous redistribution of matter and motion*" (emphasis in original).[27]

Force was also manifested in Fuller's threefold order. The starting point of that threefold order was the "Space of Three Dimensions" consisting of the entities of time, mind, and force. Although not cited, the concepts of space, time, and force appear to be directly adapted from chapter 3 of *First Principles* titled "Space, Time, Matter, Motion, and Force." Echoing Spencer, Fuller wrote that all knowledge was relative based on manifestations of force and compared to an absolute and unknowable world. Time was only cognizant by the realization that an entity had a past, a present, and a future. This realization was apparent only through the sensation of the successive positions in space that an object could occupy. This movement of objects by force was proof of space. Force was shown through the sensation of matter in motion which in itself was proof of energy.[28]

The concept of the mind in Fuller's schematic of Space of Three Dimensions was subdivided into knowledge, faith, and belief. These concepts could have been adapted from Spencer's concept of the knowable and the unknowable which were the two major subdivisions in *First Principles.* Spencer classified those as things as knowable that could be derived from the senses and could be comprehended by reason. Fuller completely adopted this definition. In Fuller's delineation of the concepts of faith and belief, however, the connection between his system of knowledge and Spencer's was more tenuous. An easy correlation may be that Spencer's unknowables, Ultimate Religious and Scientific ideas pertained to entities that could not be fully sensed or, if sensed, not fully comprehended. These could be accepted only through faith and belief respectively. Spencer never used these terms in a consistent manner and used them interchangeably. Fuller did not discuss religious beliefs or concepts at all and defined faith as the difference between belief and knowledge. In that Spencer only had two categories of knowledge, the knowable and the unknowable, it is possible that Fuller was simply attempting to preserve his scheme of threes by creating the two concepts of faith and belief where Spencer would not have differentiated.[29]

Fuller also adapted Spencer's description of order. Force caused the continual movement and redistribution of mass. This movement from indefinite, incoherent homogeneity to a definite, coherent heterogeneity was the product of evolution. It was this rise to heterogeneity that allowed organisms, societies, and armies to compete against other, less heterogeneous, entities. A more developed entity had component parts that performed specific functions in coordination with the whole, and this permitted flexibility and complexity. Fuller wrote that "organization is the vehicle of force," and he went into detail about the organization of armies and the function of each of its components, often comparing them to the human body. Through each level of organization, he showed how each component of the military structure (organized in threes, of course) contributed to a common goal. At the national level, for example, he broke the military force into army, navy, and air force. At the tactical level, he showed that an army could be composed of light infantry, heavy infantry, and cavalry, each having their special functions.[30]

Below these was the crowd. Here Fuller differed sharply with Spencer's philosophy in which heterogeneity was considered a sign of positive evolution and homogeneity was considered as evidence of something less developed or, worse, something which had devolved. Fuller, however, presents civilian crowds as heterogeneous: "a mass of individuals governed by uncontrolled desires which obliterate the individual will." He discusses armies as being homogeneous crowds where the "will of the individual is not so much surrendered to impulse as subordinated to command."[31] Reid provides an answer to this discrepancy, writing that Fuller took his description of crowds from Gustave Le Bon's *The Psychology of the Crowd*.[32] In any case, Fuller, in describing the purpose of battle, wrote that the ultimate goal was to attack the enemy organization. In a sense, by attacking the ability of the enemy to coordinate his forces, the enemy army would *devolve* into a formless, homogeneous (heterogeneous in Fuller's terms) mass. "Battles are tests of military structure, the object of each side is not to kill for the sake of killing, but for the sake of disorganizing, for military strength does not lie in individuals, but in the cooperation of individuals and masses."[33]

There are many other aspects of social Darwinism in *The Foundations of the Science of War*, as well as most of Fuller's other works; but these cannot be directly attributed to Spencer. Fuller presented war as a battle for the survival of cultures and races and self-preservation as the basic motivation for the individual. These were common ideas of the age and in accordance with Spencer's general philosophy. Fuller's Darwinism, however, had harsh, antidemocratic tones that Spencer would have found repugnant: to him, the freedom of the individual was the most important aspect of culture.[34] Fuller wrote that "our predominant difficulty is the spirit of the herd, which in these democratic times, has been deified and raised to Olympian heights,"[35] and "the masses do not like war, for they are cowardly; therefore, their political representatives shun its preparation."[36]

Fuller believed that the military arm of government needed one man in control and if the political and military leader were one in the same during war, so much the better, but he felt that democratic governments—"government by mediocrity"—would not allow this. Spencer, on the other hand, wrote that it was not a great man who was important but rather the social organizations that allowed a society to conduct war.

These differences aside, Spencer had an important and acknowledged influence on Fuller. Fuller's use of Spencer's philosophy rose above mere analogy: he did not write of war as being *like* an evolutionary process but rather that it *was* an evolutionary process. To him, the force of war and the force of evolution were one in the same. As a unifying framework, and in specific ideas such as the descriptions of knowledge, force, and order, Fuller's theory is directly attributable to Spencer. Fuller did, in fact, use Spencer as his "master and guide."

There is irony, however, in the fact that even as Fuller was attempting to create a science of war based on Spencer's philosophy and within the framework of Newtonian science, both the philosophy and science were becoming antiquated. Spencer's philosophy, that the world was ordered and without chance, died on the battlefields of France. In its place came the ideas of The Lost Generation (e.g., Ernest Hemingway, John Dos Passos, William Faulkner, Erich Remarque, and others). Those of that generation, who were younger and mere participants in the war, took a much different lesson from Flander's Field: Life was without reason and governed by chance and fate.

As for Fuller's scientific framework—that of Newtonian cause and effect—that too had died in the first two decades of the twentieth century. In 1905 Einstein published his special theory of relativity that was the first blow to Newtonian science. In the 1920s, quantum mechanics, emerging as the "new science" challenged the world of cause and effect with the much less certain world of probabilities and trends. Before addressing these new sciences—their philosophical implications and the effect they may have on military theory—it seems appropriate to review the two case studies and establish the mechanism which links science, philosophy, and military theory.

Notes

1. Will Durant, *The Story of Philosophy: The Lives and Opinions of the Greater Philosophers* (New York: Simon & Schuster, 1926), 384.

2. Jacob Bronowski, *The Ascent of Man* (Boston: Little, Brown & Co., 1973), 308. Bronowski points out that the same theory was produced independently by two men of the same time and culture through the same process. Both had even taken long voyages to the South Seas during which they postulated the laws of natural selection. Darwin had been working on his theory for almost 20 years and had shown no disposition to publish his ideas until he became aware of Wallace's work on evolution.

3. William Ritchie Sorley, *A History of English Philosophy to 1900* (Cambridge: Cambridge University Press, 1951), 267.

4. Rudolf Metz, *A Hundred Years of British Philosophy* (New York: Macmillan, 1950), 94–95.

5. Herbert Spencer, *Principles of Sociology*, ed. and intro. Robert L. Carneiro (Chicago: University of Chicago Press, 1967), *ix*.

6. Ibid., *xx*.

7. Ibid., *xvi*.

8. Ibid., *xvii*. Carneiro also notes that the term *evolution* was never used in the earlier editions of Darwin's *Origin of the Species.*

9. Ibid., *xviii*.

10. Ibid., *xix*.

11. Herbert Spencer, *First Principles* (London: Williams & Norgate, 1908), 253.

12. Ibid.

13. Ibid., 225.

14. Ibid.

15. Ibid.

16. Spencer capitalized phrases he considered key such as space, time, matter, motion, and knowledge.

17. Spencer, *Principles of Sociology, xxxii.*

18. Ibid., *xxxi.*

19. The social Darwinist philosophy was even stronger in the United States where a more intense economy and less class division gave new meaning to the "survival of the fittest." Azar Gat, *The Development of Military Thought: The Nineteenth Century* (Oxford: Oxford University Press, 1992). In this book, Gat shows how social Darwinism influenced Mahan's theory of naval power.

20. Metz, 102.

21. Brian Holden Reid, *J. F. C. Fuller: Military Thinker* (New York: Saint Martin's Press, 1987), 1–30. Although an otherwise excellent examination of Fuller's intellectual development, Reid probably does not give Spencer the credit he is due in shaping Fuller's intellectual views. Reid is also incorrect in three areas. First, he claims Spencer tossed aside British empiricism in favor of deductionist philosophy. In fact, Spencer was a continuation of the empiricist school. Metz, for example, claims Spencer's work was empiricist philosophy advanced to the highest degree. Second, Reid writes that Spencer wrote in reaction to Darwin's discoveries. As has been shown, Spencer's concept of evolution was far more involved (and predates) Darwin. Third, Reid claims that Fuller may have, in part, learned the Hegelian dialectic from Spencer, yet in *First Principles* Spencer mentions Georg W. F. Hegel only once and that is to defend British philosophy from attacks made by Hegel for being too empirical in nature. Spencer does describe a dialectic, but in that this is a product of the reaction of forces in opposition to each other, Spencer's dialectic is his own. Reid does correctly acknowledge Spencer's influence on Fuller's work where Fuller has cited Spencer as a source, and that Spencer provides Fuller a framework—evolution—for his theory, but misses Fuller's use of Spencer's concept of knowledge and which permeates *Foundations.*

22. J. F. C. Fuller, *The Foundations of the Science of War* (London: Hutchinson & Co., 1926), 196.

23. J. F. C. Fuller, *The Reformation of War* (London: Hutchinson & Co., 1923), 5.

24. Fuller, *Foundations,* 22–23.

25. Ibid., 194.

26. Reid, 18.

27. Fuller, *Foundations,* 199.

28. Ibid., 48–49. A diagram on page 49 shows Fuller's Space of Three Dimensions. Of the 12 concepts shown in the diagram which constitute space, 11 of them can be tied to Spencer's *First Principles.*

29. In his section on Space of Three Dimensions, Fuller does not reference Spencer at all.

30. Fuller, *Foundations,* 78–79.

31. Ibid., 138–39.

32. Reid, 27.

33. Fuller, *Foundations,* 102.

34. It was the role of the individual versus the state that Spencer suffered a fatal contradiction. On one hand, he always valued the rights of individuals and held up societies in which individual freedoms were preserved as evidence of a high evolutionary state since there was strength in diversity. On the other hand, if man had no free will and it was the organism as a whole that determined survival or oblivion, then the needs of the individual had to be subordinated to the needs of the many.

35. Fuller, *Foundations,* 99.

36. Ibid., 88.

Chapter 6

The Path from Science to Philosophy to Military Theory

Newton's first step in his method of investigation was to "analyze observed facts to discover the principles involved." The observed phenomena in this study have been the scientific and philosophical influences on military theory, specifically those involving Clausewitz and Fuller. The next step in the process will be to "make relevant phenomena of the field under investigation intelligible by fitting them into a system." In other words, it will be necessary to postulate a mechanism that explains how science and philosophy affect military theory.

Unfortunately, the strict rigor of the scientific method cannot be applied to the creation of this mechanism. In this study, the observed phenomena have consisted of only two "data points." Are the similarities between the two case studies truly meaningful or merely coincidence? Does the examination of only two examples show all the possible influences, or are there other ways that science and philosophy influence military theory that were not exhibited? Do the observed phenomena support a mechanism that would apply to military theories produced outside the influence of Western culture? These questions must remain unanswered. Understanding these limitations, a mechanism will be described ranging from principles which can be shown to be generally valid, to specific observations that, although valid in these two case studies, may or may not be valid for others. Finally, rather than achieving scientific proof that would demonstrate the scientific and philosophical influences described necessarily had to produce the observed military theory, all that can be achieved is a much less stringent conclusion of *suggesting* these connections based on commonalities between the two case studies.

Scientific Influences

Science attempts to describe the universe. More importantly, it does so in a way that shows the reasons events occur. Prior to Galileo, science created mechanisms that "preserved the appearances" of phenomena: They provided an explanation of an event without showing why that event had to occur in exactly the way it was perceived. All forms of human endeavor in Western civilization since the seventeenth century have been based on the cause-and-effect relationship which is the salient characteristic of Newtonian science.

Science must also describe the nature of knowledge. How is the universe perceived? What does man know? What can't he know? How does man reduce the effects of uncertainty? These questions are answered through the scientific method of investigation. In postmedieval science, this method eventually evolved into the empirical testing of intuitive thought. In terms of pure science, what was considered to be valid must be empirically demonstrated.

Uncertainty was handled in several ways. First, rigorous, repeatable tests and improved methods of observation reduced the uncertainty of observational error (as shown by Brahe's tenfold improvement of astronomical data simply through improved techniques and instruments). More importantly, Newtonian science used the concept of an absolute universe as a reference point for the perceived world in order to reduce uncertainty. By investigating the difference between what was observed and what should have been observed in an ideal state, scientists could both continually reduce uncertainty and improve understanding of the perceived and absolute universe.

Newtonian science provided Western civilization a framework for the investigation of multiple phenomena. Furthermore, this framework had to be interdisciplinary in nature by exhibiting a unifying mechanism by which the universe operates. Since Newton, simplicity has been held to be the prime virtue of a scientific theory. The first sign that a scientific theory (in fact, all theories) is becoming irrelevant occurs when incremental changes are made which make an attempt to retain relevance. Rather than a Ptolemaic system in which several mechanisms had to be described to explain the phenomenon, one mechanism had to be shown to be applicable to the entire event. In both military theories we have examined, this unifying mechanism has been the nature of force.

Science must then describe force. Newtonian physics was based around the force of gravity; the theory of evolution, which works within the framework of Newtonian science, used the force of natural selection (tied to gravity and the laws of motion) to describe why the process of evolution pertains to all phenomena. For Clausewitz this force was violence, and it was described in a manner that was similar to Newton's force of gravity. For Fuller the force was still gravity, but only as it applied to the theory of evolution through the laws of motion. To describe force, however, space, matter, motion, and time also had to be defined. As has been shown, the use of an absolute universe was crucial in these definitions.

By providing a framework for investigation—an understanding of knowledge and a description of force, time, space, matter, and motion—science showed a universe that was orderly and which operated under specific laws. It not only described events, it explained why they occur. It was the fact that the universe operated under the rule of law, and not caprice, that made theories, be they theories of science or theories of war, possible.

Philosophical Influences

If science describes the nature of the universe, philosophy describes how men fit into that universe. Philosophy acknowledged the scientific description of the universe as well as the fact that man was accountable to the same laws that applied to every other object in that universe. Philosophy, however, also highlighted man's uniqueness. To paraphrase Jacob Bronowski, philosophy explores what makes us humans and not animals.[1] In a large sense, philosophy carries on the work of science in that it tries to resolve the uncertainties of the universe that are produced in the minds of men.

Philosophy also deals with uncertainty in the same general ways as science. It must describe how humans acquire knowledge and how that knowledge produces order. In the two case studies, we saw two very different concepts of how these emerged. In the first case, Kant, while subscribing to Newton's description of the world, believed that there were aspects of man that could not be described within the framework of science. Art, beauty, and a sense of morality could not be proved or disproved through a cause-and-effect mechanism. That required man's judgment and, in rare cases, genius. Order, time, and space were modes of perception.

Kant's belief that the universe must be viewed through two separate lenses—the physical and the moral—is congruous with the new physics. In investigating the character of light, it must be examined and described through both wave and particle theories in order to achieve comprehension. Kant showed that it was not the world that was too difficult to describe scientifically; it was man. The physical could be explained while man could only be understood. With Kant as his philosophical base, Clausewitz adopted his duality of the universe as well as his concept of knowledge.

The other case, dealing with Spencer and Fuller, exhibits a different philosophy. Because Spencer viewed philosophy as being the synthesis of sciences, his philosophy is a philosophy of science. Life worked according to the unifying mechanism of evolution. Faithful to his British empirical roots, Spencer viewed all knowledge as sensory based; knowledge and order were produced from experiences of force. Fuller completely subscribed to these concepts; therefore, his theory of war was also intended to be a synthesis of ideas. It was also this philosophical background which allowed him to view the study of war as a science.

Whatever the meaning of the philosophy, like science, it had to describe the concepts of space and time and how man perceives them if it wished to describe man's place in the universe. In describing the limits of man's knowledge, Spencer and Fuller used the creation of the universe as an example of the unknowable. The universe was tied to the First Cause or the Ultimate Scientific and Religious ideas, and these were the limits of what was knowable. Both philosophers, like the scientists, used the concept of the absolute universe to explain the relative truths of the perceived world; and each military theorist adopted not only the concept but also used it in the same manner as the philosopher they used as a guide.

Philosophy interprets or synthesizes science for use by man in all endeavors. The character and meaning of a philosophy eventually permeates the military theory that uses that philosophy as a model. In the end, philosophy, like science, provides a concept of order and a method of dealing with uncertainty that makes it possible to construct theories with the confidence that the universe works according to both a moral, as well as physical, unifying mechanism.

Military Theory

Military theory describes the best way for men to wage war in the universe described by science and based on the nature of man in that universe as described by philosophy. While this study has dwelt on those frameworks and concepts that have moved on a path from science through philosophy to military theory, military theorists may take aspects of science without philosophical interpretation.

As for direct scientific influences, uninterpreted by philosophy, in both case studies, the military theorist consciously adopted the scientific framework for investigation. They used force as the unifying mechanism for their theories and described force in similar terms to the parent science. They adopted specific scientific concepts to explain their theory and, finally, they used scientific metaphors as a language to explain these theories, confident that their peers would understand them.

Clausewitz used scientific metaphors to a much larger extent than Fuller. In that Fuller believed that the laws of evolution were literally applicable to war, he had less need for metaphor. Clausewitz's use of metaphors, however, rises above the superficial. His scientific metaphors discuss not only surface similarities between scientific phenomena and warfare, they express a basic similarity of their characters. The terms *centers of gravity, mass,* and *friction* are metaphors that tie war into a unifying framework based on Newtonian science.

Military theories had to be derived from the dominant science of the age in which the military theorist lived. As part of the general society, the flagship science of the time became ingrained in him. The theorist was, in a general sense, "programmed" to view the universe in a certain manner. During Fuller's life, pivotal work was being conducted in the field of physics. But even if he had known and understood the new developments in scientific terms, he may not have been able to understand, or even care about, their philosophical importance. On a more practical level, the flagship science of the age provided a language and a symbology that other educated people at the time understood. If Fuller had described his theory in terms of the work being done on electromagnetic force or the properties of light, he would not have been understood by more than a handful of people. When he described ideas in terms of survival of the fittest, however, there was no doubt of what he meant.

The process by which scientific theories and their philosophical interpretations affect military theory occurs over long periods of time. It was more than 100 years between *Principia* and *On War* and more than 60 years between *Origin of the Species* and *The Foundations of the Science of War.* It takes time for society to digest and interpret these theories before they become ingrained into the culture (aided to some degree by philosophical interpretation).

In the end, nothing succeeds better than telling people what they already know or want to hear. Both the predominant sciences and philosophies of each age spawned and reacted to the culture. As has been shown, both the scientific and philosophical foundations of each of the case studies supported the social dynamics of that time. The part of society that tie themselves to these foundations, the educated middle class, are those which generally categorize a society. It is this part of society that, in modern times, produces most military officers.

One significant characteristic of military theory is that it, unlike scientific theories, cannot be refined by continuous testing in a controlled environment. It is fundamental to the scientific method that for a theory to be valid, there must exist the means to prove it wrong. It is one thing to create a theory that the sun will rise sometime in the future; it is another to say that it will rise at 6:42 in the morning. This theory can be proved wrong (or valid) with a simple check of the watch. Experiments that fail to produce the expected results are not necessarily viewed as failures but as part of a process of self-correction and investigation.

Without this continual self-correcting process based on continual experimentation, military theory has to make general, rather than specific, predictions. General predictions, however, are much harder to disprove. In peacetime training, and even in limited conflicts, it is difficult to sort out the "necessary" elements of a theory from friction because doctrine, technology, and world events seldom present what could be called controlled environments for experimentation. Without continual testing—the ability to prove the theory wrong—other, more human influences, come to bear on the relevance of military theory. Tradition, careerism, interservice rivalries, and domestic politics, to name only a few, allow military theories to exist long past the time when they have relevance to their environment, simply because there is no clear way to prove them wrong short of war.

Wars, especially long, violent wars, reveal what military theories are still relevant as opposed to those that have died, but went unburied. Both Clausewitz and Fuller were participants in catastrophic wars that clearly demonstrated that older theories no longer applied. These conflicts—the Napoleonic Wars and World War I—showed the biggest difference between scientific and military theory: unsuccessful scientific experiments are simply part of the process of scientific investigation; unsuccessful military experiments (i.e., war) cause the downfall of nations.

Other Possible Connections

Both cases have revealed aspects of the phenomenon that may be mere coincidence or may be necessary parts of the mechanism by which military thought is influenced by science and philosophy. First, key scientific and philosophical ideas have been described in pivotal works whose name alone came to symbolize milestones in our civilization by men who also came to be associated with the ideas of the age. *Principia*, Kant's *Critiques*, *Origin of the Species*, and *First Principles*—all of which shaped Western thought—were syntheses of ideas and concepts that had been developed across the sciences and philosophies in the decades preceding their appearance. Is it necessary that *one* work which serves as the standard for the ideas of the age be published? If *Origin of the Species* or *First Principles* had not been published, but their ideas were still disseminated by series of works by different authors, would these ideas provide a foundation for military thought? The cases imply that it was necessary; and if not absolutely necessary, at least extremely useful. In each age, it seems one person has been able to synthesize the ideas of that age and publish them with clarity. These ideas then program or galvanize society and capture the imagination of the educated middle class.

In both case studies, the military theoreticians were soldiers and scholars. Both had consciously attempted to widen their understanding of the universe through extensive reading and attending lectures on diverse subjects. Both military theoreticians were also military educators, and while they both achieved high rank in their armies, they were not classified as great commanders. (Clausewitz, in fact, writes that being a great commander and a scholar are mutually exclusive). Do military theories come from men who are personally acquainted with war, but who have also been given time to reflect on their experiences and weave them into the science and philosophy of the era? Do these case studies imply that the next encompassing military theory will be crafted by a similar sort of individual? The evidence suggests it will.

The Mechanism Summarized

1. Science provides society with a description of the universe that is unified by the properties of force. In describing force, it must also describe concepts of time, space, and matter. By providing a unifying description of the universe, science makes the creation of theory possible.

2. Science also provides a framework for the investigation of phenomena that is interdisciplinary. This framework defines knowledge and attempts to find ways to reduce uncertainty. Within the framework of Newtonian science, the use of the concept of the absolute universe was created to help reduce that uncertainty.

3. One science captures the imagination of the age and serves as the model for human enterprise, to include military theory.

4. Philosophy describes man's role in the universe. Although it accepts the vision of the universe created by science, it adapts that vision to the uniqueness of man. It further hones the concepts of knowledge and it, too, attempts to reduce uncertainty produced in the minds of men.

5. Military theory describes the best way for men to wage war in the universe based on the nature of the universe defined by science and the nature of man defined by philosophy.

6. Military theory adapts the method of investigation and the description of force used by the predominant science of the day. In addition, scientific concepts and metaphors are used to provide common language to facilitate the description of military theory.

7. Military theory, which is not subject to the rigors of scientific experimentation, remains largely untested until put to the test in war. It is after a war in which existing military theory has been shown to be in error that new theories are produced.

In the end, what this mechanism suggests is that military theorists are "programmed" by their culture to view the universe and war in a particular way. It has been shown that military theorists consciously chose to use philosophical and scientific concepts and frameworks of their time; paradoxically, they may also have had little choice in this decision. Perhaps Spencer's concept that free will is merely the manifestation of man following the path of least resistance is evident here. There may be a rare instance where a military theorist consciously chose a framework that was alien to his culture, or one that had become antiquated. If this occurred, chances are these were overcome by theories better adapted to the environment. What was left, therefore, are those theories that did operate in the scientific and philosophical belief systems of their age and, because of this, thrived.

Notes

1. Jacob Bronowski, *The Common Sense of Science* (Cambridge: Harvard University Press, 1953), 150.

2. An interesting, but only speculative, example of this may be Clausewitz's eventual acceptance outside Germany. Paret believes that Clausewitz started to be read more in France and England after Germany's victory in the Franco-Prussian War. The desire to understand the theory of a winning army undoubtedly was the largest motivating factor. During the same period, however, Kant was being widely read in England. Kantian influences helped to return some of the mysticism (although Kant would not have used the word) to British culture denied by the British empirical philosophers, especially "the terrible Hume." Perhaps with this new philosophical undercurrent, the British were able to now understand Clausewitz.

Chapter 7

The New Sciences and Their Implications for Military Theory

Now I saw a new heaven and a new earth, for the first heaven and the first earth were passed away.

—Revelation 21:1

Not only is the universe stranger than we imagine, it is stranger than we can imagine.

—J. B. S. Haldane

Two developments in physics in the early twentieth century changed our view of the universe just as drastically as Copernicus's *Revolution of the Heavenly Orbs* and Newton's *Principia* changed the view of the universe in their times. These were Einstein's theories of relativity (the first, the special law of relativity was written in 1905, the second, general law, written in 1915) and quantum mechanics which were developed by a host of young physicists in Europe in the first two decades of this century. Only a brief discussion of each of these will be given here. Even though these sciences are often counterintuitive to our daily experience, their philosophical message is clear: Newton's world of cause and effect has been encompassed by a world of probability and trend; there are specific limits to what man can know within defined limits of certainty; and the concepts of time, space, matter, and most importantly, force are drastically changed. Finally, unlike Newtonian science where the observer remains outside the event and compares what he perceives to an absolute model, the observer in these new sciences is necessarily inside the event, and just where he is inside the event determines what is perceived. The reason for all these changes between the philosophy of Newtonian science and the science of Einstein (Fuller and Spencer would have been happy to know) is a change in the understanding of force.

In this case, the force was electromagnetic energy, particularly light. Prior to 1881 it was assumed that light's speed was relative to the observer. Although the speed of light had been measured, it was believed that because the earth was moving in the Aether of absolute space at the same rate as that space, the speed of light appeared to be constant. If, however, one were to move toward or away from the source of the light, the speed of light would change based on the observer's velocity. In an experiment conducted in 1881, the American physicist Albert Michelson (he repeated the experiment with

Edward Morelly six years later, and this experiment is now named after both of them) showed that *no matter the velocity of the observer, the speed of light remained constant*.[1]

In 1905 Einstein published *The Electrodynamics of Moving Bodies* which contained the famous equation $E = mc^2$ (energy equals mass times the speed of light, squared). Einstein showed that light, energy, and mass were tied together. The simple fact that light moves at a constant speed regardless of the position or velocity of the observer killed the concept of absolute space and time that was central to Newton's physics (as well as our philosophical understanding of the universe). In Newton's absolute universe, when an event occurred, it was thought to have occurred at a single moment in time. Einstein showed that the "single moment in time" did not exist because the perception of time was different for every observer based on their positions and relative velocities. Newton's absolute time and space had formed the framework of his (and our) existence. Bronowski writes that "his is a God's eye view of the world: it looks the same to the observer, wherever he is and however it travels. By contrast, Einstein's is a man's eye view, in which what you see and what I see is relative to each of us, that is, to our place and speed. . . . We cannot know what it looks like to each of us, we can only compare what it looks like to each of us by the practical procedure of exchanging messages."[2]

Einstein published his general theory of relativity in 1915. That paper expanded the effects of the special theory of relativity to the universe. It postulated a universe that was not laid out in the framework of absolute time and space but rather was established in a curved universe that consisted of the three dimensions plus time. To understand the universe, the position of the observer and the time of the observation were tied together into "space-time." That is, a scientist did not make an observation, he observed an *event* which was understandable only if his position and the time it took from the occurrence of the event to be perceived were taken into account.

Bronowski writes that Einstein, like Newton, was a unitarian. He sought to describe the basic mechanism by which the universe operated; and to do that, he had to provide a unified description of force. He tied the concepts of "light to time, and time to space, energy to matter, matter to space, and space to gravitation. At the end of his life, he was still working to seek a unity between gravity and the forces of electricity and magnetism." Consciously, he also realized that he had changed the character of knowledge, since knowledge is built upon perceptions of space and time.[3] The philosophical implication of Einstein's relativity theory is that when an event is observed, its validity is limited to the observers perspective; others who view the event may have a different observation equally as valid. Comparing these events will allow one to create a more accurate description of the event, but this description is still not the same as that of other possible observers.

The next science to attack the rule of Newtonian physics was quantum mechanics. One of the discoverers of quantum mechanics, Niels Bohr (1885–1962), wrote, "If someone says that he can think about quantum physics without becoming dizzy, that shows only that he has not understood anything whatever about it."[4] Throughout the nineteenth century, scientists attempted to explore the nature of the smallest part of the universe, the atom. They slowly gained a recognition that atoms of different substances had different weights, but they still maintained the notion of an indivisible substance on which all matter was composed. Late in the century, Ernest Rutherford (1871–1937) discovered the first subatomic particle, the electron; and by the early twentieth century, it was felt that the atom actually consisted of several subparticles: the neutron, the proton, and the electron. The electron was depicted as revolving around a nucleus consisting of a neutron and proton.

Until the twentieth century, it was felt that man could eventually know anything simply by breaking any substance down into component parts, which in turn could be broken down to smaller component parts until it reduced to the smallest, indivisible part, the atom. We now know that at the end of that road lies not understandable atoms, but a dizzying world of muons, gluons, quarks (red, green, and blue), to name only a few, and a brick wall that limits our level of knowledge.

At the subatomic level, it is impossible to measure an event without influencing the experiment. A rough analogy is that of checking a tire's pressure: the simple fact of sampling the air pressure causes it immediately to be different than what the tire gauge reads. In physics, this occurs when attempting to determine the position and momentum of a particle. Because light itself is composed of particles, the "light" used to measure a particle collides with the object being measured and causes it to change velocity and position. It is possible to measure the track of a particle across a cloud chamber or the exact location of a particle as it hits a charged plate, but once these events occur, the particle's fate has been changed. The more accurately one tries to measure the momentum of a particle, the less accurate the measure of position, and vice versa. Werner Karl Heisenberg (1901–1976) first postulated this principle of uncertainty in 1926, prescribing specific mathematical limits for that uncertainty. The philosophical revelation accompanying the physics was the recognition of an inescapable limitation upon man's ability to perceive the universe.

A key aspect of quantum mechanics is that matter displays the properties of both waves and particles at different times, and each of these characteristics yield different but necessary information. The particle-wave characteristics of matter and the failure of the old reductionist method of investigation have given the new physics an almost mystical nature. Several books have been written comparing quantum mechanics and relativity to Eastern philosophy which requires, according to one, "a way of thinking which consists of circling around the object of contemplation . . . a many-sided, i.e., multidimensional impression formed from the superimposition formed from different points of view."[5]

In concert with this particle-wave duality, quantum mechanics has also changed the concept of force. Modern physics defines force as interacting virtual particles (which are massless) transmitted via waves at the speed of light. The four types of force are electromagnetic forces, weak nuclear forces, strong nuclear forces, and gravity. Each of these has different types of particles associated with them. The last force, gravity, around which Newtonian physics was developed, now emerges as the outsider. Its associated particle, the graviton, has never actually been observed, but only postulated. Of all the forces, gravity is the weakest but has the largest accumulated effects and acts over greater distances. More importantly, gravity is the only force that cannot currently fit into a unified theory of force that would once again tie the universe into a single mechanism.[6] A quest for a grand unified theory now occupies science. This theory would not only be important for physics but for virtually all physical sciences. It would thus become a new diagnostic tool for investigating the universe.

Until a unified theory is created, the traditional view of physics is that there are two operating systems. Newtonian science still functions for relatively slow-moving, large, heavy objects (actually anything that is visible) and is concerned largely with the force of gravity. Quantum mechanics is largely concerned with subatomic matter and is primarily concerned with the three other types of force.

Returning to the mechanism by which science eventually influences military theory, it was shown that science describes the universe by describing time, space, matter, and force; the nature of knowledge; methods for handling uncertainty; and a simplified mechanism that describes how the universe functions. The theory of relativity and quantum mechanics has redefined time, space, matter, and force. They have not, as yet, presented a unified theory of force and a unifying mechanism for the universe. Quantum mechanics shows that uncertainty cannot be eliminated but only managed by observation. In Newtonian science, repeated observations were made to reduce the uncertainty produced by the process of observation (e.g., human error and equipment tolerances). In quantum mechanics, where the phenomena are transient, multiple observations within short time spans are required to reduce uncertainty to the smallest possible level. The theory of relativity implies that the observer must be cognizant of the differences in perception between himself and other observers, and that it is only by comparing his view with others that a better (but still relative) understanding of a phenomenon may be gained.

Until a grand unified theory is worked out, is there any way of tying the phenomena of the universe together? In the large sense, nonrelativistic Newtonian physics still provides a unifying mechanism. Planets still revolve around the Sun as described by Newton, and those who wish to predict the fall of projectiles need not learn neither quantum mechanics nor relativity. Another science has appeared in the last 30 years that promises to unify aspects of the universe that until now, both quantum mechanics and Newtonian sciences have been unable to do. This is the science of complexity.

Complexity is a new science that describes the behavior of complex adaptive systems. A complex adaptive system is one without centralized control and changes to meet the demands of its environment and to compete with other adaptive systems. Complexity itself evolved from the associated science of Chaos. Chaos theory describes the specific range of irregular behaviors in a system that move or change. (A system is defined as a collection of elements along with a set of rules on how those elements interact and change.)[7] The thrust of Chaos theory is that small inputs in a closed system may produce large, unpredictable consequences, and that these systems may jump from ordered states to chaotic states based on those small inputs. In that Chaos operates in a closed system, it does not, as is commonly thought, describe a nondeterministic phenomenon. The whole point to Chaos theory is that the fate of the system is determined by small factors which become magnified over time. It is the fact that these factors are too many, and too small to know, that cause the system to be unpredictable. Chaos theory has been highly publicized in recent years in everything from movies (*Jurassic Park*) to automobile commercials. The philosophical thrust of Chaos theory is that uncertainty can be caused by small changes which, even if these changes are anticipated, results in an unpredictable system.

Complexity raises the stakes to the next level where adaptive systems that may be prone to chaotic behavior are pitted against other systems and their environment. Complex adaptive systems were first described by Dr. John Holland of the University of Michigan. Holland said that complex adaptive systems are characterized by four things. First, they are systems that are networks of "agents" acting in parallel. Examples of these come from many disciplines to include brain cells in human physiology, species in biology, and households in the economy. Control of these systems are highly dispersed. There is not, for example, a master neuron in the brain. Organization within these systems is created by both competition and cooperation with other systems.

Second, complex adaptive systems must have many levels of building blocks which comprise the next higher level of order. These systems are constantly rearranging these building blocks as they gain experience through the process of evolution. Shifting building blocks to adapt to the environment secures survival.

Third, complex adaptive systems anticipate the future. This can happen from genetic codes in each organism that cause it to react to specific events in specific ways. Each complex adaptive system has internal models built into it which serves as a blueprint for behavior. These too change with experience.

Fourth, complex adaptive systems find niches to which they adapt and thrive. As they fill a niche, other systems find niches within them. Each of these systems seeks to "optimize" its place in the larger system and is constantly adapting to each other and the environment. Change is not only constant, it is necessary.[8]

Complexity theory (as well as Chaos theory) has become an interdisciplinary concept about how the universe behaves. Murray Gell-Mann ties complexity theory to quantum mechanics. "We have to examine fundamental physics from the point of view of simplicity and complexity and ask what role is played by the unified theory of the elementary particles, the initial condition of the universe, the indeterminacy's of quantum mechanics, and the vagaries of classical chaos in producing the patterns of regularity and randomness in the universe within which complex adaptive systems have been able to evolve."[9]

Lacking for the present a unified theory of force, complexity theory has acted as a bridge between modern sciences and explains processes that are common to all of them. As some of the examples of complex adaptive systems show, the theory has been applied to societies as well. Its philosophical message is congruous with quantum mechanics and relativity. While those sciences require rapid, repeated observations to limit uncertainty to the smallest possible limits, complexity theory shows that those complex adaptive systems that are able to organize themselves to observe and act rapidly are more successful than those that don't. They do this by creating decentralized structures that recognize and adapt to changing situations based on their ingrained model of the system.

While there are philosophies of new science, there has yet to be a work that synthesizes what they mean. Many books have been written that discuss the philosophical aspects of these sciences, a few of which have been quoted in this study. Both Einstein and Bohr often discussed the effect that their discoveries had on man's understanding of the universe. Probably the closest that any single work has come to translating the meaning of new science into a form that was understandable to most people is Stephen W. Hawking's *A Brief History of Time: From the Big Bang to Black Holes.* Still, there has been no singular work that interprets the new sciences into a comprehensive philosophical framework. This may be a reflection of a lack of a mechanism in the new sciences that presents a unified description of force and, subsequently, the universe.

Is there any physical science (versus the theoretical sciences of quantum mechanics, relativity, and complexity) that has captured the imagination of our present culture and provides us a unifying lexicon and framework? There are two likely candidates: the newcomer, computer science, and the perennial favorite, biology. Computers are now omnipresent in our society. It is still a young enough science that its language remains largely understandable to the layman, and it is a science that visibly affects their lives. The recent explosion of the Internet into the World Wide Web illustrates a complex adaptive system in its truest sense. The concept of virtual reality, replicated life experiences within a computer world, has become accepted in modern societies; while it captures societies imagination, it no longer produces wonder but expectation.

As for biology, it too has regained new significance in society based on advances in the study of genetics and a new understanding of the human brain. Genetic science now permits the growth of genetically altered plants that permit them to survive in new environments. It will soon be possible to fix defective DNA codes to eliminate inherited diseases; the significance of DNA evidence is now known to everyone.

Which one of these sciences becomes the next flagship science is impossible to forecast. In many ways, the distinction between the two in terms of a general understanding is becoming blurred: It is impossible to discuss the architecture of the brain without using computer terminology; and computers are viewed as immature electronic brains. Computers have been developed which mimic the human brain; and some have been modeled on DNA architecture, which itself is compared to a computer code based on four numbers (the number of amino acids which make up the code) rather than the mere digits 0 and 1 of binary code.

As the Majestic Clockwork symbolized the ordered predictability of Newton's universe, a new symbol has been applied that ties the new sciences together: the World Wide Web. Rather than the machinelike precision that was the goal of prequantum science, it represents the concept of complex adaptive systems that is constantly evolving in an unpredictable manner by a process of competition and cooperation. It exists to process and act on information as efficiently as possible by extended action-decision nodes that need little or no central guidance. This type of organization is ideally suited for handling uncertainty described by quantum mechanics and relativity; it allows both rapid observation and correlation of events through adjoining nodes. The image of the World Wide Web has been applied across both sciences and social sciences and has been used to portray the dynamics of such diverse systems as international economies, computer networks, the human brain, and ecosystems.

One of the goals of this study was to examine what new science would provide the model for future military theory. After a brief examination of the evidence, it turns out that, like the suspects in Agatha Christie's *Murder on the Orient Express*, they are *all* guilty.

New Military Theory?

There was no need for a new scientific framework to discover that the conduct of war is full of uncertainties. Clausewitz brilliantly described the nature of these uncertainties almost two centuries ago; and an old maxim states that, in war, no plan survives contact with the enemy. There was also no need to describe the properties of Chaos. Squad leaders conduct precombat inspections and crew chiefs give bolts an extra turn of the wrench fully cognizant that little details left unchecked can have major consequences.

There are, however, some implications of new science for military theory; and true to the mechanism, it is tied to the description of force and how uncertainty is managed. Modern military theory is caught up in the same dichotomy as modern physics—which is divided between the framework that describes large bodies—and is largely concerned with gravity and the framework that describes small bodies and is connected with the other forces, particularly electromagnetic force. These can be described, respectively, as macromilitary theory, which is derived from Newtonian physics and philosophy and micromilitary theory which is emerging out of the new sciences.

Macromilitary Theory: Derived from Newtonian Sciences

Traditional military theory, which is still represented by Clausewitz, is concerned with large masses. It seeks to destroy the enemy's center of gravity that is associated with mass. This often means that this theory focuses on the enemy's armed forces and the physical destruction of his war-making capability. Although this thought is more often associated with ground forces, it is also manifested in some naval and airpower theories as well. Like Newtonian physics, its basic characteristics have remain unchanged for two centuries, which explains Clausewitz's continued relevance.

Military theory based on the force of gravitation (in the metaphoric sense) tends to be reductionist, that is, it divides war and the battlefield into hierarchical component parts. War itself is characterized as being fought at the strategic, operational, and tactical levels. The battle is broken into different activities such as offense and defense; and each of these is, in turn, described in smaller detail. The battlefield is also delineated into various components such as rear, close, and deep battle areas. This mode of thought has been labeled antiquated by some present military theorists who view force more in terms of the electromagnetic spectrum, both in the literal sense as well as a metaphoric sense.

Micromilitary Theory: Derived from Post-Newtonian Sciences

Certain parts of the electromagnetic spectrum can now be applied to create the same effects that conventional munitions traditionally produced. More importantly, however, is the capability of electromagnetic energy as a carrier of information and a source of intelligence. Modern military theories, especially those of strategic airpower advocates, focus on optimizing our ability to use the electromagnetic spectrum while crippling the enemy's ability to use it, thereby paralyzing his system.[10]

These military theories based on the electromagnetic spectrum tend to view war in a more holistic sense. In that they use a form of force that allows for quick observation and the application of force at large distances, these theories argue that the traditional levels of war tend to become blurred since the desired results may have simultaneous effects at each level. These theories look at the enemy as a complex system and attempt to destroy those things which allow that system to coordinate and adapt. In line with the parallels drawn between the new sciences and Eastern philosophies earlier, it is no accident that the proponents of these theories favor Eastern philosophies of war expressed in Sun Tzu, while those who favor traditional military theory still look to Clausewitz as their philosopher of war.[11]

Macro-Micro Duality of Modern Military Theory

It would be wrong to say that any service or any form of modern force application is inherently tied to the older force of gravitation and all that it implies, while others are purely tied to new modes of warfare based on newer models of force. Each service has attempted to look at the nature of warfare in the next century and adapted doctrine and force structure (as any complex adaptive system must) to meet the changing environment. Recent United States Army publications have discussed future tactical and operational structures which would consist of much smaller but more lethal units operating with a larger degree of autonomy that modern technology permits. A recent report from the Revolution in Military Affairs task group in the Pentagon recommended "the creation of smaller, more dispersed, but lethal military formations, noting that through the use of advanced communications, these units could immediately call in a variety of superaccurate missiles and aircraft-delivered munitions to destroy enemy formations."[12] The United States Air Force is creating a structure that has fewer airframes but is more capable of surgical attacks using precision guided munitions and stealth. In a very real sense, much of the discussion over future roles and missions is tied to the claims of each service that it can exploit what is perceived as the changing character of war.

Just as Newtonian physics and quantum physics are both required to describe the wide range of phenomena in the universe, it is impossible to comprehend the nature of war in the late twentieth century through either the macromilitary or micromilitary frameworks alone. Each has its place in the wide spectrum of conflicts the United States must be capable of conducting. The question remains, however, over what type of scenario is best suited to each type of military theory, and the argument over what force (airpower or ground power) was the decisive factor in the Gulf War is a manifestation of this debate.

Developing Trends in Microwarfare

The increased importance of the electromagnetic spectrum creates an environment in which opposing systems can change and adapt to each other very rapidly, which increases uncertainty. This uncertainty is managed in a fashion similar to quantum mechanics: through fast, repeated observations of the enemy system. This places a premium on the ability to process information accurately and quickly and is a key to understanding the now used (and overused) term *information warfare.*

One theorist who has consciously adapted scientific concepts to military theory is John R. Boyd who developed the now ubiquitous "OODA loop." OODA is an acronym for observe, orient, decide, and act. Although Boyd developed the OODA loop from his experiences as a fighter pilot, he later saw the applicability of the new sciences while pursuing a master's degree in physics. The OODA loop is essentially a process by which one focuses on observing an event and acting on it faster than the enemy. Boyd considers the second "O, orient," the most important part of the cycle. As metaphorically required by relativity theory, only by comparing the perceived event with another frame of reference, can the observer reduce uncertainty.[13] The United States Marine Corps has adopted Boyd's OODA loop in its doctrine; and the latest Army publications show that the battlefield has changed from a time when the OODA loop was measured in days during the Napoleonic wars to where it is now measured in minutes.

If scientific frameworks provide a model, future military systems will be less hierarchical and viewed as parts of complex adaptive systems. Each part of that system will be optimally positioned to observe events, correlate that observation with other parts of the system, and then react with little or no guidance from a central coordinating entity. An example of how this is done presently is the Army doctrine of giving "mission type orders" tied to a commander's intent. By receiving and comprehending a clear description of the end state that is envisioned by the commander, each subordinate unit is free to operate within preset parameters to accomplish its mission. An evolution of this doctrine based on new technologies and the implications of new science will create units with flattened hierarchies that can quickly rearrange its structure to adapt to the mission and the enemy system. This will create structures that will resemble a web of observation/action nodes.

In a study of the possible implications of complexity theory on war, Col Glenn Harned argues for the adoption of new principles of war drawn from the lessons of complexity: First, observe the system continuously and do not expect circumstances to last. Second, use the natural nonlinear dynamics of the system to apply available force to the maximum effect. This would call for analyzing the enemy in a holistic manner and applying force to cause systemwide damage. Third, forget about optimization. Rather than attempting to find the best plan to defeat an enemy, it is best to keep many options open. In war among complex adaptive systems, gains and losses are relative to each other and not tied to a textbook solution.[14]

None of these concepts are new, but can be perhaps understood differently if viewed from the perspective of scientific frameworks. If the mechanism for understanding military theory in light of scientific and philosophical influences holds true, a comprehensive military theory on a level of *On War* or *The Foundations of the Science of War* will not be written until the concept of force is unified and creates a simple mechanism to understand the universe. After that occurs, it will take some time for this mechanism to be understood and philosophically interpreted. After its implications capture the imagination of the populace, it will shape the mind of a future theorist. Even then, until present military theory fails the test of war, a new theory will remain unwritten.[15] Once all these ingredients have been met, however, a new military theory—created within the scientific and philosophical frameworks of its society and understood by that society in its own terms—will be born.

Notes

1. Stephen W. Hawking, *A Brief History of Time: From the Big Bang to the Black Holes* (New York: Bantam Books, 1988), 20.

2. Jacob Bronowski, *Ascent of Man* (Boston: Little, Brown & Co., 1975), 249.

3. Ibid., 250.

4. Murray Gell-Mann, *The Quark and the Jaguar: Adventures in the Simple and the Complex* (New York: W. H. Freeman & Co., 1994), 168. Gell-Mann won the Nobel prize for physics for his discovery of the quark. He is also heavily involved in the new science of complexity.

5. Fritjof Capra, *The Tao of Physics: An Explanation of the Parallels between Modern Physics and Eastern Mysticism* (New York: Random House, 1975), 140. See also Gary Zukav, *The Dancing Wu Li Masters: An Overview of the New Physics* (New York: Bantam Books, 1984).

6. Hawking, 69.

7. Glenn E. James, *Chaos Theory: The Essentials for Military Applications* (Newport, R.I.: Center for Naval Warfare Studies, Naval War College, 1996), 3.

8. M. Mitchell Waldrop, *Complexity: The Emerging Science at the Edge of Order and Chaos* (New York: Simon & Schuster, 1993), 145–46.

9. Gell-Mann, 120.

10. For examples of this line of thought, see Col John Warden, "The Enemy as a System," *Airpower Journal*, Spring 1995, 40–55; and Col Richard Szafranski, "Neocortical Warfare? The Acme of Skill," *Military Review,* November 1994, 41–55.

11. In interviews with Col Richard Szafranski and Col John Warden (whose "The Enemy as a System" is an ideal example of the "new" military theory described here), both said that although *On War* contained some valuable insights, they felt that Sun Tzu's *The Art of War* had more relevance today.

12. Jeff Erlich, "Smaller Units Wave of Future," *Army Times,* 15 June 1995, 30.

13. John R. Boyd, "A Discourse on Winning and Losing." This consists of locally reproduced copies of Boyd's briefing slides dated August 1987; also interview with author, 27 April 1995.

14. Glenn M. Harned, "The Complexity of War: The Application of Nonlinear Science to Military Science" (master's thesis, Marine Corps War College, 1955), 49–53.

15. Several theorists, of course, claim that the Gulf War produced such evidence.

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