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MIND OVER MACHINE:
Why Doctrine Should Lead Technological Change.

A Monograph
by

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Corps of Engineers

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ABSTRACT

MIND OVER MACHINE: Why Doctrine Should Lead Technological Change.
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This monograph explains why doctrine should lead technology in developing and sustaining a durable American way of war. It describes and examines the dynamic relationship between doctrine and technological change and its basis in theory and fact. It answers the research question: ***Should military doctrine lead technological change or should technological superiority foster the development of military doctrine.*** It tests the hypothesis: ***If doctrine leads technology, then technological change will synergistically leverage advancements in both towards decisive victory and a durable American way of war.***

To facilitate reader understanding of this topic and most clearly present the material, the monograph is structured in the following way. Section II, THE DOCTRINE-TECHNOLOGY DYNAMIC, introduces the relationship between theory, doctrine, and technology within the rubric of modern operational art. Section III, *ANALYSIS AND EVALUATION*, presents the advantages and disadvantages of leading with doctrine versus technology in the evolution of modern operational art, accompanied by historical examples of each strategy. The intent of this section is to form the basis for testing the hypothesis and answering the research question. Section IV, CONCLUSIONS AND IMPLICATIONS, offers an answer to the research question and closure concerning the validity of the hypothesis. It also addresses implications, strategic through tactical, for leading with doctrine versus technological change for both combat and operations other than war.

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I. INTRODUCTION

Every part of war is touched by technology and every part of technology affects war.[1] Technology completely permeates the concept and conduct of the American way of war for both combat and operations other than war.[2] It pervades why we fight, what we hope to achieve by fighting, and how we envision our relationship with the nation we serve. It penetrates our planning, preparation, execution, and evaluation; our operations, intelligence, organization, and supply; our objectives, methods, capabilities and missions; our command and leadership; and our strategy, doctrine, and tactics. In short, nothing in the American way of war is immune to the impact of technology.[3]

In our American way of war, *theory* and *combat* are, respectively, the model and reality of modern operational art. Theory, the product of critical analysis, evaluation, and interpretation,[4] attempts to explain the role and predict the conduct of combat across the levels and domains of war. Helping to define its physical, cybernetic, and moral dynamic are *doctrine* and *technology*. Technology and technological change, more than simply the hardware of battle, embody a universal system of knowledge, attitude towards war, and method for solving operational and tactical problems.[5] Doctrine represents both an authoritative guide to fighting and conducting

operations other than war, as well as a description of how American Army officers think about their profession.[6] Doctrine distills theory's generalities into rules of action, so necessary to the commander in the chaos of battle, and guides him in developing vision and intent across all domains of battle and at all the levels of war. Doctrine links strategy, history, technology, the enemy, interservice capabilities, and our nation's political policies to create the conditions for decisive tactical victory[7]; that link is at the heart of the doctrine-technology dynamic. This monograph explores that dynamic and attempts to provide historical and logical insight into whether doctrine or technology should be preeminent in the evolution of modern operational art.

In this attempt, the monograph answers the formal research question: **Should military doctrine lead technological change or should technological superiority foster the development of military doctrine?** The words *lead* (to guide on a way especially by going in advance; to direct on a course or in a direction[8]) and *foster* (to cause to progress or proceed towards a goal[9]) are used intentionally. The notion of doctrine leading technology posits that it is more prudent to develop an acceptably flexible and robust doctrine across the entire spectrum of conflict, based upon sound theoretical and tactical principles, to leverage new technologies when they become

available. The opposing position implies that it is more advantageous to spend fiscal and mental capital on a strategy of technological superiority with doctrine in a subordinate role designed and redefined for exploiting emergent capabilities or leap-ahead technologies.

The phrase *technological change* is also chosen specifically to encompass two elements: *invention* (fabrication of a useful device, contrivance, or process originating from study, ingenious thinking, and experimentation[10]) and *innovation* (the introduction of a new idea, method, or device[11]). It is important to recognize the distinction between these two processes in understanding the nature of the research question, the hypothesis, and the doctrine-technology dynamic itself. Invention implies doctrinal development and innovation, technological superiority, as the key mechanism in the evolution of modern operational art.

According to Klaus Knorr and Oskar Morgenstern of Princeton University's Woodrow Wilson School of Public and International Affairs, an *invention* is the creation of a new idea [*for* a weapon] and an *innovation* is the choice of which new ideas to develop.[12] Stephen Rosen, author of **Winning the Next War** (Ithaca, NY: Cornell University Press, 1991) makes the distinction between a *tactical innovation*[13] (changing the way individual weapons are

applied to the target and environment in battle) and a *major innovation*[14] (a change in the concepts of operation of an armed force, that is, the ideas governing the ways it uses its forces to win campaigns). Tactical innovations favor decentralization where operating units and individuals collect all the relevant data themselves and innovate without the need for organizational changes elsewhere in the Army.[15] This is clear and distinct from major innovations which are unprecedented and involve a change in the relation of the Army to its sister services and possibly downgrading or abandoning older concepts of operation and formerly dominant weapon systems.

The development of Army helicopter aviation in the early 1960s illustrates this point. The Army took a fresh look at land warfare mobility and developed new fighting concepts and resource requirements around the helicopter and airmobile divisions.[16] As a result, the Air Force's traditional close air support roles and missions with fixed wing assets added less value to the force as a whole. The new Army divisions designed around the rotary wing platform would, by themselves, rapidly transport infantry and artillery units into close proximity with the enemy while helicopter gun ships in the accompanying air cavalry brigades would seek out and attack these same positions.[17] The formation of the First Cavalry Division (Airmobile) and its eventual assignment to combat

operations in Vietnam in 1965 is testimony to this vision.[18] Though the concept of land mobility was changed by the helicopter and airmobile operations, the Army's essential role was unaltered.

Changes in the Army's formal doctrine that leave its essential workings unaltered are not major innovations.[19] Though evolving doctrine compels Army officers to think differently about their roles and missions for both combat and operations other than war, within the nation's strategic security framework, it leaves intact its essential charter: decisive land combat as a member of a combined arms team.[20] Consequently, doctrinal innovation, though a virile generator of overwhelming combat power, cannot be considered a major innovation according to Rosen.

For this monograph, *invention* implies the discovery or creation of a new technology based upon a preexisting concept (or doctrine) for its employment and presupposes that new capabilities will be employed as designed; it occurs primarily in private industry. *Innovation* implies that a new technology, once fielded, will be modified, in an incremental fashion, by its users (soldiers) and employed in ways originally unintended; it naturally occurs in the military.

Accordingly, the essence of the doctrine-technology debate, by measure of peacetime efficiency, technological

competitiveness, crisis flexibility[21], and decisiveness in combat is as follows: whether it is more effective to develop doctrine to lead market forces and pull inventions from the private sector based upon our American way of war and concept of future battlefields or to expect the ingenuity of American soldiers using available technologies derived from private industry, and its market forces, to innovate *de facto* doctrine.

The significance of this research question to professional Army officers is easily understood when one considers several factors. First, the assumptions which heretofore underpinned our post-World War II defense technology strategy were founded upon the Soviet threat and its well understood capabilities.[22] As the twenty-first century unfolds and the strategic security environment shifts away from the Cold War bipolar world and the threat of high intensity conflict towards compounded global uncertainty and regional disturbances,[23] these assumptions become increasingly invalid and obsolete. Second, the study of technological change in the military has not progressed with the same fervor that it has in the private sector. As a result, the very process of technological advancement is poorly understood[24] and there are no clear cut models for the mechanisms and subtle forces which drive it in the military.[25] There has been sufficient study, however, to realize that military

technological change is not easily explained by the same market forces, such as demand-pull or technology-push, that are used to describe the phenomenon in private industry.[26] Specifically, the relative importance of demand in the field of military technological change is clearly more complicated than what is normally described in private industry according to classical economic theories.[27] This implies that developing and fielding the latest and most lethal technologies in the military is, at best, a misunderstood mechanism and, at worst, a haphazard and extremely costly process. Focusing on technological superiority and this essentially random procedure as the driver of modern operational art is illogical, reckless, and historically dangerous. Additionally, with significant defense budget constraints expected for the foreseeable future, a "hit and miss" technology strategy based upon misunderstood or unknown factors is not prudent in gaining and sustaining political fiscal support.[28]

If technological superiority is to be a critical element of and precondition for decisive victory, we must understand technology's full impact on combat effectiveness across the physical, cybernetic, and moral domains of battle. This entails recognizing technological change as a social process[29] and identifying the mechanisms which drive innovation of superior technologies, either market forces in private industry or demands created by

evolving military doctrine. It also implies understanding how these technologies are then most effectively used in combat and how they should be adapted to counter the changing threat. Finally, it means answering the research question and deciding whether to place primacy on doctrine or technology as the engine of change[30] in the evolution of modern operational art towards overwhelming combat power and decisive victory.

To this end, the monograph tests the formal hypothesis: ***If* doctrine leads technology, *then* technological change will synergistically leverage advancements in both towards decisive victory and a durable American way of war.** Technologies necessarily reflect the values and aspirations of their makers. Whether consciously espoused or not, they pervade the entire spectrum of development and are particularly important in setting the subsequent course of new technologies. As products of particular segments of society (such as our Armed Forces), technologies are loaded with ideological, hence doctrinal, implications.[31] To quote a Hebrew proverb, "The deed accomplishes, what thought began."[32] The thought, *doctrine*, must shepherd the deed, *technological change*, in a focused fashion. It will propagate new technologies that shape the conduct of modern combat and operations other than war. These will,

in turn, affect our doctrine by amending the way we think about operations. The impact of these technologies will be felt directly, at the point of application of a new weapons system as well as indirectly through soldiers' innovations, eventually to become integrated with formal doctrine and other technologies in the underlying infrastructure of modern society.[33]

The doctrine-technology debate has inspired academic attention without consensus, as authors champion both sides of the question. This monograph contributes to the intellectual discourse of the profession of arms by introducing several arguments of logic, with supporting historical examples, and by offering a conclusion based upon their relative merits. The methodology pursued seeks first, to investigate the nature of doctrine and technology and their bases in theory and fact; and second, from this investigation, make a qualitative judgment concerning the relative efficacy of doctrine leading technological change or technological superiority fostering doctrinal development. The hypothesis was tested based upon the advantages and disadvantages of each strategy. The historical examples offered are not meant to be exhaustive nor definitive. They serve, cumulatively, to give perspective to the logical arguments which, in themselves, span the history of armed conflict

and operations other than war in Europe and the United States since the advent of the Industrial Revolution.

To facilitate reader understanding of this topic and most clearly present the material, the monograph is structured in the following way. The following section, THE DOCTRINE-TECHNOLOGY DYNAMIC, introduces the relationship between theory, doctrine, and technology within the rubric of modern operational art. Section III, ANALYSIS AND EVALUATION, presents the advantages and disadvantages of leading with doctrine versus technology in the evolution of modern operational art, accompanied by historical examples of each strategy. The intent of this section is to form the basis for testing the hypothesis and answering the research question. The final section, CONCLUSIONS AND IMPLICATIONS, offers an answer to the research question and closure concerning the validity of the hypothesis. It also addresses implications, strategic through tactical, for leading with doctrine versus technological change for both combat and operations other than war.

II. The DOCTRINE-TECHNOLOGY DYNAMIC

The relationship between theory, doctrine, and technology is essential to the doctrine-technology dynamic and this monograph in how it frames the research question and hypothesis. The interaction between these three elements is itself dynamic and iterative, making its underlying driving forces and mechanisms all the more critical to understanding the current debate and the evolution of modern operational art.

Theory is "an analysis of a set of facts in their relation to one another; the general or abstract principles of a body of fact, a science, or an art."[34] Systems analysis and the laws of probability describe it as the *decision space*[35] (where things happen), its boundaries, and the relationship of the variables therein. It is a model, an interpretation and explanation of "why" things happen the way they do. When the interpretation is valid, the model accurately predicts the outcome of future events under similar circumstances.[36] Such an interpretation is inherently empirical and necessarily formed with a historical perspective. As a result, its nature is universal, enduring and pervasive, so long as the sample is representative of the phenomenon and the observer injects no bias into the process. However, the key to understanding theory is in its application. This application is enunciated through the *Principles of War*

which describe the accepted truths of combat and operations other than war.[37] These generic and universal axioms form a logical framework and help us to understand the interaction of variables within our decision space. However, they cannot prescribe immediate actions, nor forecast the *sequels* and *branches* to specific campaigns or battles and, consequently, provide commanders little or no local combat insight. In the chaos and urgency that is modern battle, the opportunity costs of time lost in searching for such insights are overriding. The solution in our American way of war is an action oriented focus at the operational and tactical levels, that is, *doctrine*.

The US Army defines *doctrine* as "the statement of how America's Army, as part of a joint team, intends to fight and conduct operations other than war. It is the condensed expression of the Army's fundamental approach to fighting (campaigns, major operations, battles, and engagements), influencing events in operations other than war, and deterring actions detrimental to national interests. As an authoritative statement, it is definitive enough to guide specific operations, yet adaptable enough to address diverse and varied situations worldwide.[38] It also describes how we think about applying the basic principles of warfare in the environment and under the conditions we may be called upon to fight."[39]

This doctrine is grounded in the theories of Clausewitz and Jomini, among others, who used the Napoleonic campaigns as their basis in fact. These campaigns, as examples of conventional conflict, are robust as they portend the timeless friction and fog all commanders face in battle. However, when Jomini and Clausewitz wrote their great historical works in the 1820s, they based their reflections on the assumption that technologically things would continue much as they were. Neither man understood the decisive role technology could play in the outcome of wars.[40] As a result, applying Clausewitz or Jomini verbatim has limited value in planning modern campaigns. If not interpreted with some flexibility, they may form a flawed basis upon which to incorporate the technological advances of our age into doctrine for fighting and conducting operations other than war in the future.

US Army doctrine also represents applied knowledge from further analysis of history and military theory, specific to our circumstances of threat, budgetary constraints, and advanced technology. Its scope is more narrow than theory and, as a result, is fleeting in many respects, intended to evolve with changing conditions and circumstances. Paradoxically, just as it is volatile it is also permanent and universal, inexorably linking the way we think about war to the way Napoleon conceived his

Danube Campaign in 1809, to how Grant envisioned the Virginia Campaign in 1864-65, or to how the *Wehrmacht* envisaged the 1940 campaign through France. Doctrine is, in part, the viable distillation of past collective military genius into postulates of action tailored to today's modern battlefield. Through doctrine, the complexity of battle is condensed into a finite set of specific guidelines which increase our probability of success. This is done, first, by steering commanders clear of previously made mistakes (branches) along similar decision paths and, second, by decreasing decision time, thereby increasing freedom of action. In terms of our decision space, this increased freedom of action means more options, and, by definition, better solutions. Doctrine helps funnel the wisdom of history and the dynamic impact of technology to the decisive point on the battlefield where they can be most effectively synchronized towards overwhelming combat power.

Technology is a pervasive force in the evolution of warfare and operational art. It represents the changing capabilities of battle as well as the ways in which they are physically employed to effect results. It is also not a stationary target, making its classification and forecasting all the more difficult. It bounds the decision space, with doctrine, that defines the menu of feasible options from which the commander must choose to

prosecute modern operational art. It is, in turn, affected by the changing theory and doctrine which it serves to underlie.

As the changing succession of equipment employed in war indicates, the forces of technology play an important role in military affairs. Men from the earliest times applied their genius to design and produce better weapons, so that military technology has rarely stood still for very long. It remains in a state of almost continuous turbulence with "currents, tides, whirlpools, and eddies almost too numerous to analyze and understand."[41]

Technology first penetrated the modern doctrine-technology dynamic in the period after 1830 when, as the result of the Industrial Revolution, it became institutionalized, sustained, and predictable. Especially after World War I, military technology fostered a new prevailing view of the nature of war itself: where once war had been thought of as man versus man, it was increasingly seen as a contest between machines that were served, maintained, and operated by men. From the idea that war was primarily the business of machines, it was only a small leap of inference to believe that if only the right weapons could be found they would constitute "ninety-nine percent of victory."[42] However, as the fascination with modern technologies and weaponry grew, it became clear that modern warfare was extraordinarily more

complex than the classical combat, theory, and doctrine which had proceeded it. This evolved more from an appreciation of how difficult it was to synchronize new technologies across the domains and levels of war than with mastering the actual hardware itself. It also reflected the realization that technological change, and the thought which accompanies it, had to include how professional forces would maintain, supply, develop doctrine, strategy, tactics, techniques, and procedures for employing the new systems.

There was another distinction between pre- Industrial warfare and its modern counterpart. Where classical strategy for land warfare could be transformed relatively quickly, as was the case for the French Revolutionary armies under Napoleon, these changes were not necessarily caused by technological innovations. In most cases, improvements in training, organization, and doctrine were effected to overcome technological limitations that had previously confined strategy "in a straightjacket."[43] This implies that in modern combat, wartime technological innovation is limited in its impact, if in fact it occurs at all. The time it takes to accomplish all the necessary tasks to fully incorporate a new technology into the modern army's structure, intelligence network, and doctrinal scheme is long, relative to the length of the war.[44] Consequently, innovation is essentially tactical in

nature, necessarily limited to the specific technology and circumstances. It does not address how technologies are synchronized with other systems or doctrines for operational results.

Military organizations, with uniform standards and centralizing tendencies, have encountered resistance to technological change; more from within than without.[45] The way people initiate and respond to change depends on who they are, what they do, how long they have been doing it, and how they perceive the potential costs and benefits of the technology in question. Questions of status, tradition, and control thus loom large.[46] Institutional flexibility, particularly the ability to alter or circumvent standard bureaucratic procedure when necessary, assumes a critical role in fostering innovation. Without such flexibility, even the most promising technologies or concepts can fail to materialize.[47]

In this regard, military organizations were, and are less flexible than most large bureaucratic structures for several reasons. First, the compartmentalization which comes from military secrecy makes it difficult to freely exchange ideas and to assemble all the bits and pieces needed for inventing. Second, military organizations are designed to operate in a medium of very great uncertainty, namely, war. This causes them to put a premium on subordination, discipline, hierarchy, and rigid social

structures, all of which represent the direct opposite of flexibility. Finally, the need to operate in a highly uncertain, confused, and stressful environment causes them to invent their own forms of communication which would be purged from the ambiguity and redundancy indispensable for free, undirected thought.[48]

The history of individual inventions bears this out. Inventors form Leonardo to the present very often had military uses in mind (and turned to the military for financial support). However, all the most important nineteenth century military devices originated in the minds of civilians. During the twentieth century, too, none of the most important devices that transformed war -- the airplane, the tank, the jet engine, radar, the helicopter, or the integrated circuit -- owed its origins to a doctrinal requirement.[49] This is not to imply, however, that these inventions were unaffected by doctrine.

Successful employment of "superior" weapons to generate overwhelming combat power has always involved striking a complex balance between several interrelated and competing factors. In almost every case, new weapons caught the enemy materially and, more importantly, psychologically unprepared to resist. They were not so new, however, that they precluded extensive prior experimentation, training, and doctrinal formulation by

the side using them. While no weapon can be successful unless it is supported by the appropriate technical-logistic infrastructure, that infrastructure cannot grow into an impediment in its own right. Integrating new systems with older, existing ones is a must, but that integration cannot lead to a loss of independence and flexibility. In this regard, the successful use of the new weapons often involves a conceptual side-stepping, so to speak, a rethinking not merely of tactics but of operations and how to achieve the desired political end state. It is not a question of doing the same thing better, but of doing something altogether different.[50] This is the business of farsighted doctrine and a durable American way of war.

The benefits of technological superiority, where it can be established and maintained, are not evenly distributed. They vary according to the environment in which war is waged. Everything else being equal, the simpler the environment the greater the military benefits technological superiority can confer. At sea and in the air, technology is required not merely to augment man's fighting capability, but for his sheer survival. By contrast, the army's terrestrial environment is much more complex, involving terrain, lines of communication natural and artificial, obstacles, as well as battlefield clutter. The net effect is to diminish the benefits of superior

technology to the extent that it can be integrated with all these factors. Hence a complex environment, more than a simple one, tends to give the advantage to the superior tactician. That side wins that is best able to comprehend the *totality* of factors involved, and then uses them to advantage.[51] Since the human element or moral domain of war constitutes by far the most complicated environment in which war can be waged, technological superiority proved least effective in operations like the German delaying campaign fought through the former Yugoslavia in 1944-1945 against Marshal Josip Tito's Communist National Army of Liberation partisans. Needless to say, nontechnical factors, such as doctrine, leadership, discipline, and courage are capable of imposing limitations on technological superiority.[52] Consequently, a superpower's technological superiority can be trumped by a lesser nation's adoption of attrition strategy or hit and run tactics. For example, Lawrence of Arabia's desert operations in the Middle East against the Turkish Army during World War I, reflecting the Clausewitzian notion of the "battle offered but not accepted."

To this end, the conduct of war against an intelligent opponent differs from managing large-scale technological systems. Efficiency and effectiveness, the concentration and employment of the greatest possible force on the one hand and military success on the other, are not the same

particularly in the short run. On the contrary, there are any number of occasions when military effectiveness is not only compatible with diminished efficiency but positively demands that it be sacrificed.[53] Consequently, the logic which drives victory in war is opposed to the logic which fosters technological efficiency.

III. ANALYSIS and EVALUATION

This section of the monograph explores the advantages and disadvantages of the two opposed strategies in the evolution of modern operational art. As such, it forms the basis for answering the research question (*Should military doctrine lead technological change or should technological superiority foster the development of military doctrine?*) and coming to closure concerning the validity of the formal hypothesis (*If doctrine leads technology, then technological change will synergistically leverage advancements in both towards decisive victory and a durable American way of war.*)

DOCTRINE-LEAD: ADVANTAGES

1. Doctrinal development can occur even in a hostile peacetime environment without an accompanying increase in funds for technology.

The development of a durable American way of war, in the form of doctrine, can be accomplished at relatively little expense when compared to the enormity of R&D expenditures and time investments required for advanced technologies. Farsighted peacetime military innovation was possible in the American military, even during the 1920s and 1930s when military budgets were tight and popular attitudes toward the military were far from friendly. This was also true in the 1950s, when our

military bureaucracy had swollen in size far beyond its pre-World War II levels.[54] Budget drawdowns, an uncertain global environment, and an increasing number of congressmen and senators without military experience all do not preclude the US Army from being visionary in our approach to combat and operations other than war. The same cannot be said for a strategy of technological superiority.

2. Considers the human element and all domains of battle as well as the desires, values, and interests of our nation.

The nature of our doctrinal development process necessarily links the strategic, operational, and tactical levels of war, as well as the physical, moral, and cybernetic domains of battle. It also leverages new technologies as they become available. A technology based strategy does not holistically consider the human factor in the equation, instead it aims simply to determine how to best eradicate it as the source of error and miscalculation. Additionally, a technology based strategy does not adequately address the synergistic effect of alternative technologies or strategies across the spectrum of conflict.

3. Considers doctrinal combinations (asymmetric forces) between services to exploit the synergy which is the combined arms team. Accommodates risks and gambles as a part of the decision environment.[55]

Technology based strategies function upon a cost-benefit analysis, where risks and gambles are inherently discouraged, without some anticipation of accelerated or increased return on the investment. Doctrinal strategies *require* that alternatives be explored and different combinations be exhausted within existing doctrine and equipment, as well as those of sister services and agencies. This cannot be said for a technology based approach.

DOCTRINE-LEAD: DISADVANTAGES

1. The military, as a culture, is too conservative

On the whole, military organizations tend to be conservative in their approach to technological innovation, for various reasons. Sometimes the resistance reflects fears concerning the impact that a new technology (or doctrine) will have on the structure of the organization and the status of the personnel involved. A decision to go for a novel technology which will yield its fruit (if it ever does) some time in the future may be delayed. The effect this has on unit readiness or the potential for overwhelming combat power should not be taken lightly.[56] If a new technology emerges which

provides the military with a leap-ahead capability, doctrinal inertia may not allow the organization to leverage or effectively employ it with the required speed for overwhelming combat power and decisive victory. Pride of authorship is also a factor in this regard.

The classic example is perhaps the French military during the interwar period and their doctrinal emphasis on firepower and the methodological battle. French military doctrine after World War I was the work of a larger portion of their officer corps, not the product of the High Command or a single individual.[57] In this regard, they were an enlightened force by current American standards. However, as the years between the wars passed, the French Army, especially the artillery, became increasingly conservative and protective of its doctrine and the methodological battle. It focused increasingly on infantry forces performing the principal mission of combat supported by fires from artillery tubes and other systems. The new machines of war were seen as auxiliaries of the infantry.[58] Consequently, leveraging the advantages of maneuver provided by, for example, the tank, was impossible. Though the French were willing to consider and incorporate new ideas into their doctrine early on during the interwar period, they became ossifed and inflexible. In 1940 they were brutally beaten by the German Army which had learned the importance of rapid

decentralized operations in mobile warfare from their experience in World War I.[59]

2. Long lag time for assimilating technology.

Fielding technologies based upon a concepts driven system, much as we now use, can cause significant lags from concept to effective use.[60] Training, technical expertise, and tactical proficiency are compromised at the expense of increased casualties.

As an extreme example, the two key elements of AirLand Battle, armored vehicles and the helicopter, were both envisioned by Leonardo da Vinci in the fifteenth century. In the American Civil War, both Union and Confederate soldiers were armed with rifled muskets of unprecedented range and accuracy. However, the armies initially approached each other in Napoleonic formation which proved so costly that, by the end of the war some four years later, both sides had developed dispersed formations and crude infiltration tactics."[61]

TECHNOLOGICAL SUPERIORITY: ADVANTAGES

1. Technological superiority is suited to quick and decisive victory, vice protracted conflicts.

Other things being equal, in the "conventional" world the importance of military technologies depends upon the length of the conflict. The shorter the war, the greater

the importance of weapons and weapons systems. The longer it is, the greater the role of military activities other than fighting pure and simple, and the greater the role of technologies that impinge on these activities or govern them.[62] If the next decade brings conflicts and political circumstances which may preclude the Army from using overwhelming force towards a quick decisive victory, our technological superiority may be trumped by nations or groups with a longer term view of the conflict. America's involvement in Vietnam, where the North Vietnamese *dau tranh* strategy precluded the effects of our overwhelming combat superiority and tactical victories.[63] The US Army's recent success in Desert Shield and Desert Storm, however, supports the contention that, in a short conventional campaign, overwhelming technological superiority is a key ingredient for quick and decisive victory with minimum casualties.

2. Technological superiority increases the decision space.

A strategy of technological superiority increases force capabilities, thereby increasing options for the commander and expanding his decision space which is the "key to success."[64] This strategy encourages the natural greed of civilian inventors to seek out military financial support with technologies that have battlefield

application. Fielding these general concept technologies for soldiers to innovate battlefield uses bases emerging doctrine on empirical research, that is, use in the field rather than a theoretical "crystal ball." The long lag times experienced in a doctrine based approach are reduced, if not eliminated.

TECHNOLOGICAL SUPERIORITY: DISADVANTAGES

1. Technological superiority increases the uncertainty in war.

As the process of continuous technological innovation became established, after 1830, and sometimes yielded great victories, it also gave rise to a host of equally great problems. Perhaps the most important of these was the addition of a fresh dimension to the uncertainty which constitutes the normal environment of war.[65] More capabilities with more systems means more "moving parts" to any organization or course of action. The more moving parts, the greater the friction and the more chances for things to go awry.

2. Opportunity costs of technological superiority in terms of training, doctrine, and operations are great

Although technological superiority can be very important in war, its effect is not equally great under all circumstances, and even where it is very great, it will seldom on its own decide a war. Technological

superiority, like anything else, carries a cost. If this cost is not carefully studied and managed it may increase to the point where the adverse effects exceed the benefits. As early as the last decades of the nineteenth century, the numerous changes in weapons and equipment led either to a badly trained army or to one that was well-trained but heterogeneous, belonging to different technological ages.[66] This problem dealt as much with inadequate logistical support, in terms of ammunition, fuel, and repair parts, as it did (and does) with maneuver and firepower. The logistical trail necessary to support a technologically heterogeneous force is significantly larger than one for a homogeneous force.

From the point of view of the American Army's function, which is decisive land combat as a member of a combined arms team, an even greater threat may be the possibility that rapid turnover in technology contributes to an equally great turbulence in doctrine, training, organization, and the personnel structure. Coupled with the specialization that is a necessary condition for, and an outgrowth of, the use of sophisticated technology, such turbulence may contribute to a loss of institutional memory and of cohesion, possibly even to disintegration to the point that the force will no longer be capable of fulfilling its military mission.[67]

3. The military is a good environment for innovation, but not for invention.

Although armed forces in many ways represent an ideal environment for undertaking technological development, they hardly offer a climate that is favorable for invention.[68] Invention, driven by market forces or other dynamics not necessarily in tune with battlefield needs, forces the military to live with other than optimal technologies and capabilities. Innovation is essentially a tactical process, not concerned with how systems integrate or should be synchronized at the operational level. Consequently, innovation is not a sound basis for how to think about battle nor a good foundation for a durable American way of war.

4. The logic of war and the logic of technological superiority are essentially opposed.

The underlying logic of war is not linear but paradoxical. The same action will not always lead to the same result. The opposite is closer to the truth. Given an opponent who is capable of learning, a very real danger exists that an action will not succeed twice *because* it has succeeded once.[69] The logic of technology is based upon efficiency which sires standardized and centralized systems, decreasing the enemy's need to deal with uncertainty and increasing his chances of success. This tendency towards standardization and central control

conflicts with the realities of modern combined arms warfare, as it tends to slow action leading to inertia, not agility, momentum, or initiative.[70] The logic of technology and technological superiority also refers to a desire to eliminate human error from operating processes. It evokes the terms *uniform* and *modern*, specifically meaning machines, versus *conventional* meaning people. In this sense, conventional also means backward or primitive along with a reliance upon people; people mean emotion and error.[71] Nothing could be more dangerous in armed conflict than to rely more heavily upon weapons systems at the expense of the soldiers who they serve to augment. There are no technological fixes.[72]

Since technology and war operate on a logic which is not only different but actually opposed, nothing is less conducive to victory in war than to wage it on technological principles. The successful use of technology in war very often means that there is a price to be paid in terms of deliberately *diminishing* efficiency.[73]

The allied invasion of the European Continent during World War II, Operation OVERLORD, and its accompanying deception plan, Operation FORTITUDE serve as an illustration. In May and June of 1944, the radio nets of the mythical First United States Army Group came alive to portray Lieutenant General George S. Patton, Jr. as the

dashing battle captain who would lead the allied invasion across the Pas de Calais. Dummy camps sites and deceptive troop movements in eastern England served to reaffirm the myth in German minds. While this inefficient allocation of resources, in the technological sense, was misleading the enemy, the real OVERLORD invasion force was concealed in southern coastal England. On the morning of 5 June 1944, when the invasion commenced, Operation FORTITUDE had succeeded in setting the tactical conditions for operational and strategic victory.[74]

5. *Technological dependency is dangerous.*

It would be a mistake to believe that because technology represents a starting point for thinking about war it represents the only or even the best starting point. Technology alone cannot dictate the conduct of war or lead to victory.[75] Technology is not "objective" or "given," it is the product of specific historical circumstances. As Clausewitz cautions, since these circumstances are always in a state of flux, what is useful at one moment is likely to be out-of-date, even positively harmful, in the next.[76] One cannot logically template one's own circumstance on other periods in history as a basis of analysis or justification in fact.[77] To key on technology as the preeminent mechanism for victory is to run the risk of lulling the force into a

false sense of security, away from the agility and versatility required of successful operations.[78] Technological dependency, especially with regard to becoming overly reliant on foreign systems is both illogical and dangerous. The Toshiba Corporation's sale of submarine silent screw technology to the USSR in the early 1980s serves as an illustration. In this case, a key element of our technological superiority over the former Soviet Union, that is, the secrecy and surprise afforded by this technology, was compromised by Japanese entrepreneurial greed as was, potentially, the foundation of our strategic nuclear defense.[79]

These advantages and disadvantages form the basis for answering the research question and testing the validity of the formal hypothesis. The conclusions and implications drawn in the next section are also based upon this analysis. More reliance is placed upon the arguments of logic themselves, and their relative merits, vice the historical examples, which were introduced only to lend perspective rather than proof positive of the efficacy of one strategy over another.

V. CONCLUSIONS and IMPLICATIONS

There is no weapon without its limitations and no technology so perfect that it cannot be countered by the appropriate organization, training, and doctrine. The more complex the environment in which a conflict takes place, the greater the prospect of doing this successfully.[80] With the probability of large scale conventional conflict waning, the necessity of dealing in complex military and diplomatic situations becomes increasingly more urgent. Consequently, how we think about employing the US Army and its technological capabilities in these multidimensional, multivariate situations is critical. How professional officers think about the US Army and how it should be employed is at the heart of doctrine.

The answer to the research question (*Should military doctrine lead technological change or should technological superiority foster the development of military doctrine?*) is that doctrine should always lead technological change for the following reasons:

1. Only a farsighted doctrine will foster a durable American way of war.

If the US Army is to remain a durable force with a viable contribution to make to our nation's security, it must be able to plan, execute, and anticipate operations

and contingencies in both war and operations other than war across the physical, moral, and cybernetic domains of battle. As described above, only a doctrine lead strategy accomplishes this with any certainty

2. Combat Functions.

Technology has not changed nor will change warfare's functions, its "timeless verities of combat."[81] They are rooted in the very nature of war and thus immune to technology and the kind of change it effects. Supplying and communicating, gathering intelligence and securing against surprise attack, fixing the enemy, maneuvering, and protecting the force all were just as vital to a Neolithic horde as they are to the modern army.[82] The logic of war, that logic which in turn dictates the essential principles of its conduct, is likewise immutable and immune to any amount of technology that is applied to or used for it.[83] By definition, a critical element of doctrine is to describe how we think about applying these immutable principles of warfare in the environment and under the conditions we may be called upon to fight. Technology is only one of the variables, or conditions, in the equation. It should not, logically, be the basis for thinking about the fundamental conduct of war nor the planning and execution of specific operations.

3. *The Human Dimension*

The idea that war is primarily a question of technology and ought to be waged employing technologically -derived methods, and must seek victory by acquiring and maintaining technological superiority is neither self-evident, nor correct.[84] There is no "rational" calculation capable of causing the individual to lay down *his* life. On both the individual and collective levels, war is therefore primarily an affair of the heart. It is dominated by such irrational factors as resolution, courage, honor, duty, loyalty, and sacrifice of self. None of these have anything to do with technology, whether primitive or sophisticated. The will to fight is the ultimate arbiter of battles.[85] Only a doctrine-lead strategy squarely confronts the human dimension of war, both on the battlefield and at home, to both energize and leverage this potent combat multiplier.

4. *The Logic of War versus the Logic of Technology.*

The logic of warfare and the logic of technology are inherently opposed. Nothing could be more dangerous at the tactical level than to be big, ponderous, and predictable. Technological efficiency leads, unfortunately, to this end. The focus of the US Army must be on its end state, that is, a durable American way of war, all the while understanding the assumptions and logic

upon which that way of war is based. Technological superiority cannot fill the void of bankrupt conceptual precepts when circumstances or assumptions change. With an increasingly unstable and uncertain future on the horizon, technological superiority cannot be unconditionally assumed as the key to overwhelming combat power or decisive victory. In fact, circumstances may preclude its use in large measure. Consequently, if nothing more than to hedge this uncertainty, doctrine must lead the US Army into the twenty-first century.

5. Military Effectiveness versus Wealth Maximization.

Market forces and entrepreneurial greed do not equate to the forces or functions which dictate battlefield success. Technological change must be channeled toward a specific military end to preclude these market forces from compromising the menu of technologies available to the military commander. A decreased number of options implies a smaller decision space meaning, by definition, poorer decisions.

6. Strategic Invention versus Tactical Innovation

Technological innovation, that is, changes in procedures or products by soldiers in the field, is specific and narrow, primarily tactical in nature. As a result, innovation in a specific Battlefield Operating

System (BOS) or weapon directly impacts that point, not the force as a whole. Consequently, the logic of developing doctrine for the entire force across all domains, BOSs, and levels using technological innovation as the scheme is dubious and poorly conceived. It ignores the criticality of cybernetic forces in combat and operations other than war.

7. *Old threats are no longer valid.*

The global strategic environment grows increasingly uncertain and US strategy can no longer based upon threats from the former Soviet Union and its Warsaw Pact allies. Because of their increasingly technological nature, future battles based on these threats would be more capital intensive. To hedge against declining support for high cost military machinery and increasing budgetary constraints, doctrine must lay the framework for how we think about fighting in this uncertain environment and how we should justify procuring more advanced capabilities. Only doctrine can effectively tie policy to fighting tactics, techniques, and procedures.[86]

8. *Synchronizing the Menu of Technologies.*

Ultimately, technological superiority is less critical and less important than achieving a close "fit" between one's own technology and that which is fielded by the

enemy. The best military technology is not that which is "superior" in some absolute sense. Rather it is that which "masks" or neutralizes the other side's strengths as it exploits his weaknesses.[87] Neutralizing enemy strengths and exploiting his weaknesses is the business of doctrine and a durable way of war.

9. Military doctrine shapes more than military technologies.

Technological superiority based upon a long range view of war will synergistically foster new doctrine and technologies in the future. The role of the military has been significant in shaping the technologies, the productive activities, the social organizations, and the power relationships in modern society.[88] By establishing standards and specifications for various goods and contracting with private manufacturers for their production, the military influences the design of many artifacts that eventually enter civilian use.[89] Once the potential usefulness of a new concept is recognized, no organization is better placed than the Army to guide its development and bring it to fruition. Compared to almost all other organizations in the modern world, the military possess tremendous technological resources. And the military is often able to deploy those resources regardless of foreign considerations, including the very important one of financial cost. As the Manhattan Project

showed, necessity -- particularly if it can be represented in terms of a national emergency -- knows no bounds. In the words of Adam Smith, "the one thing more important than opulence is defence."[90]

Concerning the formal hypothesis (*If doctrine leads technology, then technological change will synergistically leverage advancements in both towards decisive victory and a durable American way of war*), by measure of peacetime efficiency, technological competitiveness, crisis flexibility, it is fair to say that a doctrine based approach, both logically and historically, will properly guide invention in the private sector as well as innovation within the ranks. Only such an approach is effective in leading theoretical and technological advancements towards a decisive and durable end. Technological superiority is a critical component of the American way of war; however, worshipping too fanatically at its alter is surely a formula for defeat.

ENDNOTES

[1] Martin van Creveld, **Technology and War: *From 2000 BC to the Present*** (New York: The Free Press, 1991), 311.

[2] **Department of the Army, Field Manual 100-5 Operations (FINAL DRAFT)**, 19 January 1993, Chapter 8.

[3] van Creveld, 1.

[4] Carl von Clausewitz, **On War** (Princeton, NJ: Princeton University Press, 1984), Book Two, Chapter Five, 156.

[5] van Creveld, 312.

[6] Field Manual 100-5, 1.

[7] Ibid.

[8] **Webster's Ninth New Collegiate Dictionary**, 1985 ed., s.v. "lead".

[9] Ibid., s.v. "foster".

[10] Ibid., s.v. "invention".

[11] Ibid., s.v. "innovation".

[12] Klaus Knorr and Oskar Morgenstern, *Science and Defense: Some Critical Thoughts on Military Research and Development*, Policy Memorandum No. 32, Center of International Studies, Woodrow Wilson School of Public and International Affairs, Princeton University, mimeo, 18 February 1965, 3-4.

[13] Stephen Peter Rosen, **Winning the Next War: *Innovation and the Modern Military*** (Ithaca, New York: Cornell University Press, 1991), 7.

[14] Ibid., 25.

[15] Ibid., 7.

[16] Secretary of Defense Robert McNamara memorandum, 19 April 1962, reproduced as an appendix to *Howze Board*, as quoted in Rosen, 86.

[17] Frederic A. Bergerson, **The Army Gets an Air Force: *Tactics of Insurgent Bureaucratic Politics*** (Baltimore, Maryland: The Johns Hopkins University Press, 1980), 124-132.

[18] John J. Tolson, **Vietnam Studies: *Airmobility 1961-1971*** (Washington, DC: Government Printing Office, 1973), 52-4.

[19] Kevin Patrick Sheehan, *Preparing for Imaginary War: Examining Peacetime Functions and the Changes of Army Doctrine* (Ph.D. diss., Harvard University, 1988), 352-6.

[20] Field Manual 100-5, 2-5.

[21] James Blackwell, *Prospects and Risks of Technological Dependency*, Strategic Concepts in National Military Strategy Series, Strategic Studies Institute, US Army War College (April 1, 1992): 33.

[22] Ibid.

[23] Gordon R. Sullivan and James M. Dubik, *Land Warfare in the 21st Century*, Fourth Annual Conference on Strategy, Strategic Studies Institute, US Army War College (February 1993): 33. Also, Anthony H. Cordesman, *Compensating for Smaller Forces: Adjusting Ways and Means Through Technology*, Strategic Concepts in National Military

Strategy Series, Strategic Studies Institute, US Army War College (April 1, 1992): 1.

[24] Blackwell, 29.

[25] Rosen, 40.

[26] Ibid., 44.

[27] Merton Peck and Frederick Scherer, **The Weapons Acquisition Process: *An Economic Analysis*** (Cambridge: Harvard University Press, 1962): 236.

[28] Blackwell, 34.

[29] Merritt Roe Smith, ed., **Military Enterprise and Technological Change: *Perspectives on the American Experience*** (Cambridge, MA: The MIT Press, 1987), 23.

[30] Field Manual 100-5, 2.

[31] Smith, 6.

[32] van Creveld, 320.

[33] Ibid., 2.

[34] **Webster's**, s.v. "theory".

[35] *Decision space* is that physical and theoretical domain in which the commander and his force prosecute the operational art. FM 100-5 (FINAL DRAFT), p. 2-5 describes its essence in terms of *options*. The key is always to deny the enemy options for victory while maximizing one's own. In the broader spectrum of decision science, specifically linear programming, decision space is the *feasible region* of solutions for a given scenario; it can be visualized as a two-dimensional surface overlain on an

X-Y Cartesian plane. The limits, or boundaries, of this region for the operational commander are technology, doctrine, organization, battle command (leadership), and environment (METT-TL). Optimality forces the commander to maximize the area bounded by these limits; the larger the area, the greater the number of feasible solutions and, by definition, the better the quality of the resultant decision. This is analogous to the commander's desire to leave open as many options for himself as possible while denying them to his opponent. The reference in the monograph to decision space is intended to highlight this analogy and the obvious similarities.

[36] Eric von Hippel, **The Sources of Innovation** (New York: Oxford University Press, 1988), 7. A lengthy discussion of accuracy versus precision and the subtle differences between predicting and forecasting as they apply to the quality of statistical models is unwarranted. Suffice it to say, an alternative phrasing in this case might be "a model will precisely forecast future outcomes." However, Clausewitz was right in warning against templating one historical event on another time and place and attempting to forecast the future from a sample size of one (1).

[37] Field Manual 100-5, Chapter 2.

[38] Ibid., 1-1.

[39] Ibid.

[40] van Creveld, 167-8, 219. He adds, "Writing in the 1820s, Clausewitz only devoted a passing glance to the question of armament, and then only to belittle its importance. Since he died aged fifty-one, it is anybody's guess whether his eyes would have been opened by the technological revolution that was just around the corner, or whether he would have followed the example of Jomini and become ossified in his own system."

[41] Ibid., 217.

[42] Ibid, 225.

[43] Peter Paret, *Napoleon and the Revolution in War*, in **Makers of Modern Strategy: *From Machiavelli to the Nuclear Age***, ed. Peter Paret (Princeton, NJ: Princeton University Press, 1986), 123-127 and van Creveld, 167.

[44] Rosen, 38.

[45] Smith, 22.

[46] Ibid., 23.

[47] Ibid., 29.

[48] van Creveld, 220.

[49] Ibid.

[50] Ibid., 227.

[51] Vice Admiral Stanley R. Arthur and Marvin Pokrant, *The Storm at Sea*, **US Naval Institute Proceedings** 117 (May 1991), 87.

[52] Richard Rustin, *Tito and His Partisan Army: Yugoslavia 1941-1945*, **Strategy and Tactics** 81 (July/August 1980), 5 and van Creveld, 229.

[53] van Creveld, 318.

[54] Rosen, 60.

[55] Field Manual 100-5, 2-5

[56] van Creveld, 223.

[57] Robert A. Doughty, **The Seeds of Disaster: *The Development of French Army Doctrine 1919-1939*** (Hamden, Connecticut: Archon Books, 1985), 6.

[58] Ibid., 91.

[59] Ibid., 105.

[60] Christopher Bellamy, **The Future of Land Warfare** (New York: St. Martin's Press, 1987), 135.

[61] Christopher Bellamy, **The Evolution of Modern Land Warfare: *Theory and Practice*** (London: Routledge, 1990), 38-9.

[62] van Creveld, 312.

[63] Douglas Pike, **PAVN: People's Army of Vietnam** (Novato, California: Presidio Press, 1986), 213-232.

[64] Field Manual 100-5, 2-4.

[65] von Hippel, 3-6 and van Creveld, 230.

[66] van Creveld, 231.

[67] Ibid.

[68] Trevor N. DuPuy, **The Evolution of Weapons and Warfare** (New York: Da Capo Press, 1984), 300 and van Creveld, 232.

[69] Clausewitz, **On War**, Book Two, Chapter Two, 140 and van Creveld, 316.

[70] Field Manual 100-5, 2-5 and 2-12.

[71] Noble, 333-4.

[72] Dr. Marvin Miller, Class Notes from Massachusetts Institute of Technology Course 22.81 **Energy Assessment**, Fall 1990.

[73] van Creveld, 319.

[74] Russell F. Weigley, **Eisenhower's Lieutenants**: ***The Campaign of France and Germany, 1944-1945*** (Bloomington, Indiana: Indiana University Press, 1990), 75.

[75] van Creveld, 6.

[76] Clausewitz, **On War**, Book Two, Chapter Five, 157-169 and van Creveld, 232.

[77] Ibid., 164.

[78] Field Manual 100-5, 2-7.

[79] Course notes from Executive Masters in Business Administration, University of Hawaii at Manoa. Developed from notes of field trip to Japan, varied course readings, and interviews with Toshiba Corporation executives concerning this specific case.

[80] van Creveld, 230.

[81] DuPuy, 326.

[82] Tom Arielly, *Doctrine vs. Technology: A Blueprint for the Future*, **Armor** 101 no 2 (Mar-Apr '92): 29-30 and van Creveld, 314.

[83] van Creveld, 314.

[84] Ibid., 312.

[85] Lord Moran, **The Anatomy of Courage** (Garden City Park, New York: Avery Publishing Group, Inc., 1987), 13-14 and van Creveld, 314.

[86] Blackwell, 34.

[87] Arthur and Pokrant, 87 and van Creveld, 320.

[88] Noble, 346.

[89] Smith, 6.

[90] Adam Smith, **An Inquiry into the Nature and Causes of the Wealth of Nations** (Oxford: 1776; reprint edition by R.H. Campbell, A.S. Skinner, and W.B. Todd, Oxford: Oxford University Press, 1976), 431 (page reference is to reprint edition).

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