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A RAND NOTE

NEW TECHNOLOGY FOR LAND WARFARE: SOME OBSERVATIONS ON SOVIET AND U.S. APPLICATION OF PRECISION WEAPONS AND AUTOMATION (U)

Lawrence K. Gershwin and John K. Walker, Jr.

October 1980

N-1156-NA

Prepared For

The Director of Net Assessment, Office of the Secretary of Defense

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PREFACE

This Note reports the results of a project to examine some aspects of the ability of the United States and the Soviet Union to exploit new technology for the conduct of land combat operations. The Note should be of use to those in the Office of the Secretary of Defense and the U.S. Army who are concerned with U.S. and Soviet technology assessments, land warfare doctrine, battlefield automation, and antiarmor weapons.

This work was sponsored by the Director of Net Assessment, Office of the Secretary of Defense.

SUMMARY

Military technology plays an important role in the long-term competition between the United States and the Soviet Union. Although the technology and weapon systems that each side employs are often compared, much less attention is devoted to comparing the institutional, cultural, and historical factors that produce long-term differences in how effectively each side is able to absorb new military technology. This efficiency is determined by such factors as the evolution of doctrine and tactics, the adoption of suitable command and control procedures, and the flexibility of the force organizational structure to adapt to technological innovations.

The incorporation of technological innovations occurs as a two-stage process: In the first stage, the innovation is adopted as an improved means of performing a familiar function; in the second, the innovation's capabilities to perform new functions or new combinations of functions is realized, leading to new forms of operations or revolutionary changes. The second step is unlikely to occur until after the innovation is adopted, because human beings are limited in their ability to assimilate new information or to adopt new ways of doing things.

Technology in the development process is programmed through three formal channels: doctrine, organization, and material. These channels merge in the assessment process, which includes testing, evaluation, and cost and effectiveness analyses. Assessments are made with regard to perceived goals, both in the narrow technical sense of specific performance objectives and in the broad sense of relations to battlefield objectives and of national perceptions of military power objectives in a global environment. Underlying this process are national, cultural, historical, technological, and institutional factors which, though pervasive and slow to change, provide the inputs for technological innovation and affect the mechanisms for adaptation. Developments which are compatible with this base, its derivative military establishment, and the methods of assessment will be more efficiently incorporated than those which are in conflict.

The assessment function is performed more narrowly by the United States than by the Soviet Union. The Soviets place less direct emphasis on military capability than does the United States in evaluations of relative standing. For the Soviets, political trends count more heavily. The United States attaches greater significance to the technical performance of military equipment in its evaluations than do the Soviets, who emphasize troop motivation and other nontechnical factors. And the U.S. R&D process permits a greater degree of suboptimization than is apparently accepted in the Soviet system.

In measuring the effectiveness of antiarmor weapons, for example, U.S. evaluations focus on the direct effects of killing armored vehicles, whereas Soviet evaluations are more aggregated, with the primary measure of effectiveness being the rate of advance of units, quantified at lower levels as the time required to achieve specified objectives. The Soviet evaluations, because they are more aggregated, can more readily incorporate such factors as suppression and disruption, which affect mobility and the rate of advance. Individual high-performance demands are submerged with degradations both expected and tolerated. In contrast, the U.S. focus on vehicle kills emphasizes the achievement of individual high-performance standards, such as weapon system accuracy and lethality, and fails to account for more qualitative battlefield effects, such as the degradation of effectiveness. The United States has thus come to depend increasingly on the ability of technological superiority to redress numerical imbalance. In so doing, it runs the risk that the natural degradations of performance in battle will offset this potential edge, or that the Soviets will achieve and maintain technological comparability. The Soviet approach seeks to create opportunities to exploit U.S. weakness, using indirect means, such as suppression and C^3 interference, to reduce the effectiveness of U.S. weapons and means of force control, whereas the more direct U.S. efforts focus on attacking Soviet strength and killing large numbers of armored vehicles employed in an offensive thrust.

DEVELOPMENT PHILOSOPHY

The basic difference in development priority between the United States and the Soviet Union may be characterized as follows:

Criterion	*Priority* U.S.	*Priority* USSR
Weapon effectiveness	1	3
System effectiveness	2	2
Force effectiveness	3	1

Despite such differences in approach, the Soviet and U.S. development systems tend to produce basically similar end products and military hardware items, although they are designed in response to different drives under quite different views of the conduct of combat. Timing and volume of production often reflect reaction to a perceived threat or initiative by the opposition. The Soviets appear sensitive to threats and quick to develop counters. Evidence also suggests that they are becoming more aggressive in development and are fielding equipment items that are in themselves major innovations rather than component innovations on otherwise proved systems. Furthermore, the pace of introduction seems to be accelerating, as in the case of the main battle tanks that recently appeared. Hardware similarities aside, however, the real difference lies in how the end products are employed on the battlefield.

The reasons for these differences in approach are complex. In the United States, optimism regarding the potential effectiveness of new technology is based in part on a national aversion to assuming a long-term military burden in the absence of the threat of war. The wars of the 20th century have not been fought in the United States, and this country has had the luxury of sufficient time to mobilize its resources and technological strength to create overwhelming military power to fight overseas wars. In the United States, trade-offs between domestic affluence and military investment and procurement--"guns versus butter" --are considered distasteful.

Optimism regarding the performance of equipment and personnel in war is grounded in Western cultural beliefs of human potential and a view of technology as the greatest source of the nation's strength and affluence, both today and tomorrow. Moreover, the West--particularly the United States--has long believed that this country is technologically far ahead of the USSR and that the latter could never catch up. Technology has come to be believed in as providing the salvation for an otherwise unbearable, long-term military burden.

The possibility that some U.S. technology is not really superior to that of the Soviets, or that the mere existence of the technology or of high-quality weapon systems is not enough to maintain military superiority or equivalence, should be the subject of intense debate. However, faith in technology has become so strong, and the commitment of the political and military establishment to this premise so thorough, that institutions appear incapable of making the required changes if, for example, it were admitted that serious degradations in battlefield capability are normal and that a much larger investment in equipment and personnel is necessary to alleviate the unrealistic dependence on undegraded high performance. Technology has been viewed by the West as its only alternative in compensating for the increased numbers of Soviet military equipment.

Soviet failures have occurred in the past when the USSR has been completely outclassed in military technology. The Soviets have addressed themselves to this problem in land warfare by systematically adopting a continuous stream of technology development, so that several generations of equipment are either in the field or under development. Many are only marginal improvements to proven systems, or a synthesis of proven components. This approach is based on the Soviet accommodation to the realization that change is a natural process, that obsolescence, being inevitable, should not engender anxiety, and that continuous modernization is required to maintain technological comparability. American faith in undegraded high technical performance, on the other hand, is conducive to treating developments in a discrete, rather than continuous, basis, and is inharmonious with the burden imposed by natural obsolescence. Budgetary competition among candidate U.S. systems leads to an irregular step function pattern of modernization; commitment to a single system is nearly complete on each step.

ATTITUDE TOWARD DEFENSE

For the Soviets, the enormous losses experienced in war justify a continuing emphasis on the defense of the homeland, not as a burden, but rather as an obligation by both the state and the citizen. The problem is perceived from a long-term perspective, embedded in the struggle between the Soviet Union and its historic enemies, the West and China. Experience makes the realities of war more vivid to the people of the USSR than to the people of the United States and makes the Soviets more attentive to the implications of having to fight a war.

TROOP PERFORMANCE

The Soviets, because they are deeply pessimistic about men's performance under stress, do not depend on high performance. Rather, they apparently seek to maintain a continuity of operations despite degraded performance and to muddle through better than the less-prepared enemy. Operational success depends on large numbers, continuity, and speed, simultaneously attacking the enemy's means of control and degrading his effectiveness. To harden the troops to the realities of war and to keep them from collapsing, the Soviets focus constant attention on every detail of political and military training.

THE INFORMATION REVOLUTION AND BATTLEFIELD AUTOMATION

The development process for new weapon systems has been scrutinized extensively, and weapon systems are the focus of attention in U.S. military system evaluations because of their clearly defined role. While remaining obsessed with the notion of substituting technology for masses of men or material, the United States may have tended to underplay the dependence of most advanced technology on rapid and reliable C^3 in any conflict environment. Battlefield automation technology represents one of the more visible systems providing the military with infrastructure. The recent agonizing over what to do about C^3 is symptomatic of an inability on the part of the defense establishment, in the context of the budget-dominated acquisition process, to attempt to understand the implications of maintaining a coherent capability to fight in wartime, as opposed to managing a peacetime bureaucracy. Attempting to consider C^3 separately from weapon systems exemplifies the lack of appreciation of military reality.

Although the United States has consistently maintained an enormous lead over the USSR in the technology of battlefield automation, the value of this lead has been eroded because of an inability to take advantage of the technology and to field a first generation of automated systems. In fact, the Soviets are ahead in the process of training their forces to use automation and in integrating automated systems into battlefield employment doctrine and operations.

Despite their severe technical limitations in this area, the Soviets were able to formulate a plan for the development and employment of battlefield automation, based on a high-level awareness of the impact of the impending information revolution on military affairs. This vision, necessary to sustain a long-term plan which initially showed little payoff, was free of the inhibitions imposed by an existing technical establishment.

In contrast, U.S. high-level military leadership in the area was nonexistent, in part because of a well-established civilian technical community, and in part because of great discontinuities in the military effort. Rapid technological change and the consequent dilemma of technological obsolescence led to paralysis and inaction in the development and acquisition of systems. Of even greater concern is the failure to appreciate the utility of battlefield automation and the lack of a strategy to implement this technology when it finally does materialize. The Soviets have a clear means for assessing the value of automation. Automated operations consume less time than manual operations, and the use of automation with real-time battlefield models enables commanders to assess their options more quantitatively and systematically. The use of automation also reduces human errors due to degradations, avoids delays, and provides greater assurance for continuity of action.

The inability to formulate measures of effectiveness for C^3 in U.S. analyses has resulted in the failure to perceive the potential value of automation for wartime operations. The technology has been widely applied to peacetime and rear-area support functions, where its contribution is clear and familiar. On the other hand, the use of such simplistic measures as armored vehicle kills, based on unrealistic weapon effectiveness assumptions, suppresses the contribution of C^3 and inhibits the ability of C^3 systems to compete for attention and funding in the budget process.

For the United States, the built-in dependence on superior technical performance and the need to maintain enthusiasm for the virtues of advanced technology, particularly weapons, inhibit proper consideration of the realities of the battlefield. The implications of these realities might restrain the enthusiasm for technology and thus weaken the cornerstone of U.S. military posture. As this dependence on advanced technology increases, driving requirements for technical performance upward, the costs constrain the quantities procured, thereby increasing the dependence on undegraded high performance.

The Soviets, however, are serious in their willingness to compete in the technological area and have achieved comparability, perhaps even superiority, in land warfare technology. Yet they have been able to hedge their bets and have not abandoned the imperative that new technology is useful only if available in large numbers. Thus, their land warfare strategy, based on a view of battlefield reality, establishes a coherence for the assessment of the contributions of such disparate technologies as precision weapons and battlefield automation to their own capability, and also provides an understanding of how to undermine the technological strength of Western enemy forces through the widespread use of relatively unsophisticated, but highly effective, countermeasures. The ability to think through the realities of the battlefield, based on a willingness to face the possibility that war could actually occur again, is fundamental to the difference between the United States and the USSR in regard to the efficient utilization of new technology.

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TABLES

INTRODUCTION

The Soviet Union and the United States are engaged in a long-term competition, as the leaders of the two major world alliances. This competition has many dimensions; of particular significance is the military competition. Because the competition is long term, each side will gradually alter its military posture, develop and deploy new military systems, and thereby affect its position relative to the other. A significant aspect of this process is the ability of each side to exploit new technology for military application and to gain advantages through the incorporation of new technology into its military forces. This aspect of the long-term competition is the subject of this study. We shall concentrate on the technology for land warfare, with particular emphasis on two diverse technology areas--precision antiarmor weapon systems and battlefield automation systems. The impact of strategic policy on technology exploitation is beyond the scope of this study.

Although much attention has been given to the relative capabilities of weapon systems and the technological strengths and weaknesses of the two powers, far less attention has been given to the ability of each side to utilize new technology efficiently and to gain the advantage that new technology potentially can offer. The efficiency with which new technologies are converted into military capabilities is determined in large measure by how well the military system as a whole incorporates and exploits new developments, including the necessary evolution of doctrine and tactics, the adoption of suitable command and control procedures, and the flexibility of the organizational structure of the forces to adapt to innovation.

Human beings can assimilate new information more readily when it is consistent with how they already view things. To the extent that something new seemingly contradicts, or is inharmonious with, their previous experience, it may be consciously rejected or even just disregarded. Jervis(1) has looked at how perceptions are formed and altered in the case of individuals involved in international politics. He suggests that the problem lies in the difficulty that people have in giving up the ideas with which they had become comfortable, until the impact of new ideas becomes so strong that their previous views become wholly untenable.

ARMORED WARFARE AND TECHNOLOGICAL INNOVATION

This characterization by Jervis, while seemingly quite abstract, really has great support from historical experience. Luttwak, in a review of books about J.F.C. Fuller and Basil Liddel Hart,(2) discusses various responses to the possible revolution in warfare offered by armored vehicles.

Following World War I the tank was viewed by military establishments as a useful support weapon, capable of suppressing enemy direct fire in order to allow foot soldiers to advance. Lighter, faster tanks were conceived to operate as the horse cavalry traditionally operated: protecting flanks, exploiting breakthroughs, pursuing retreating enemy forces, and engaging in reconnaissance.

> These tactical conceptions were the most natural response of conservative military minds faced by the major technical innovation of armoured, cross-country, fighting vehicles. Instead of rethinking tactics *ab initio*, in order to formulate new methods that would fully exploit the potential of the technology, the new weapons would be absorbed into the established patterns of thought and action. By handing over the new class of armoured fighting vehicles to the traditional institutions, the disruption of habits, roles and missions would be minimized.

Britian, France and the United States Resisted Change

Throughout the 1920s and 1930s attempts to introduce innovation in armor were rebuffed by the military organizations of Britain, France, and the United States, and there was little experimentation with new tactical organizations to exploit the potential of these vehicles. Despite the historical lesson that the nature of warfare changes, it was more comfortable for military leaders to hold onto existing precepts, given that the possibility of actually having to fight another major war on the European continent was practically unthinkable at that time.

The military establishments were inflexible and rejected the ideas advanced by Fuller and Liddell Hart, that a new form of warfare would be centered around the tank, with high-speed operations and large-scale maneuvering of forces, dynamic rather than static--the antithesis of the enormously destructive trench warfare of World War I. Such operations in fact were not new, but had been forgotten, and Liddell Hart suggested that historically they had been much more successful than the predictable, direct assaults on the enemy's strength. *Strategies based on defeating the enemy by disruption were preferable, in his mind, to those based on attrition.*

Luttwak suggests that the British Army and perhaps the society as a whole was totally unsuited for thinking of warfare in such dynamic terms.

> . . . The deeper obstacle to innovation was not intellectual but rather sociological and even cultural. If it is to succeed, armoured warfare must be manoeuvre warfare, and manoeuvre is not mere movement but rather action in relation to the enemy, the tactical purpose of which is to apply one's own strength against the weakest points of the enemy array rather than to muster strength against strength, as in attrition warfare.
>
> . . . fluid armoured manoeuvre requires the command initiative of a mass of anonymous junior officers rather than the single brilliant general.
>
> . . . The British army cultivated the measured cadence of the infantry, and it had all the qualities of good infantry, steady and reliable, and also slow. But in war made fluid by reciprocal movement, sheer speed of thought and action is of the essence: the job quickly done is often better than the job thoroughly done. There was nothing in the life of the British army that would encourage the drastic urgencies of successful, high-risk, high-payoff mobile war, where victories are won by the sudden breakthrough and rapid advance to some decisive point, often by forces by then very weak in themselves, and at times seemingly about to be overwhelmed.

Most Americans, too, failed to grasp the significance of the new technology.

> . . . Strategies of attrition came naturally to the Americans, who could expect to have more of everything than

> their enemies, as well as air superiority. Indeed, given the imbalance of resources, attrition was the rational choice for the Americans.
>
> . . . for the Americans as for the British, generalship was largely a matter of deploying greatly superior forces in the general direction of the enemy. A sense of poverty of means, as in the German case, or a refusal to accept the human cost of attrition, as with the Israelis, are the preconditions of a "manoeuvre orientation". As Liddell Hart pointed out, the "Indirect Approach" is first of all a state of mind.

Germany Exploited Innovation

Guderian was heavily influenced by Liddel Hart and Fuller, but he made the essential next step of trying out these ideas of mobile warfare by experimenting with forces on a large enough scale to reveal the additional necessary developments for making the idea workable--flexible radio communications and integrated air attacks.

> . . . Guderian, the former signals officer, could appreciate very well the centrality of command, control and communication in armoured manoeuvre. Nothing in Fuller or Liddell Hart could have helped Guderian to design the superb command system and radio net of the panzer formations (actually their sole area of consistent technical superiority). Liddell Hart did explain very clearly that information itself is the key weapon of armoured manoeuvre, whose highest goal is precisely to defeat the enemy by paralysing his command. But from the abstract generality to the realization of agile command systems in a military hierarchy inherently rigid, the distance is very great, and some of the problems that must be overcome are of great subtlety.

Germany could not hope to match the combined resources of Britain, France, and perhaps the United States on its western side as well as the Soviet Union to the east, so the need for more efficient utilization of its resources and the emerging technology was obvious. Although the Germans enjoyed neither great technical superiority in tanks nor numerical superiority during the early days of World War II, their skill in employing tanks in new and different ways was responsible for their enormous success and the image of armored invincibility that they created.

INNOVATION AS A TWO-STEP PROCESS

The absorption of new technology may be thought of as a two-step process. It is most natural to expect that new or improved technology in the *early stages* of application will be used to replace something, but will continue to perform more or less the same function. There is less disruption of institutions and ways of doing things when new technology is used in a familiar role. Thus antitank guided missiles initially were thought of in the U.S. Army as a replacement for the unguided recoilless rifle, extending the effective range but being employed in much the same old way. In the process of familiarizing the troops, gaining wider experience, and acquiring confidence in using new equipment, the possibility naturally arises of discovering ways to better utilize the new technology or of integrating diverse elements in order to capitalize on them to perform a new function. This gradual process may be in response to changes in enemy equipment, doctrine, or operational factors that are suddenly perceived as requiring a new look at the overall military relationships and a rethinking of the utilization of military assets of all kinds. Thus the second step in technology absorption is the transition from using new technology to perform familiar jobs to employing the technology in different ways, as in the earlier example of tanks and mobile warfare. And often this second step requires technological advances in other fields, as in the case of improved radio communications for armor.

In hindsight it is easy to think that the new applications should have seemed apparent and that the first step could have been omitted. However, with few exceptions in the military or civilian areas, this is not generally the case. Most often new technology is developed and new systems are fashioned in response to identifiable deficiencies, and the earliest application is a one-for-one substitution. Attempting to go directly to entirely new applications ignores the finiteness of the human capacity to absorb change. Familar ways of doing things are not easily discarded, and few people possess the vision to anticipate the ultimate benefits of technological innovation while simultaneously having the power to implement it rapidly.*

Most military institutions are inherently conservative and tend to follow tried, understood, and traditional ways of doing things, especially those things which may involve considerable physical danger. Individual members of these institutions often are more conservative than the institutions themselves, preferring to continue to perform and to teach task performance as they were taught or learned in the "last war." This tendency is further reinforced by the corps of older noncommissioned officers who in peacetime are the primary trainers of new enlistees and who set the minds of individual soldiers. It is through demonstration, familiarity, repeated contact, schooling, and field exercises that these noncommissioned officers are updated on new developments, and only when they accept the change does innovation seep down to the implementing soldiers. So early exposure of a fairly large population of officers and noncommissioned officers to new systems appears indicated. One means for facilitating the absorption process is to broaden the role of early operational testing in such a way as to familiarize a large number of ultimate operators and users with the new technology and to break down the resistance to using unfamiliar equipment. This type of operational testing would not be performed solely to test and select particular hardware for development and production, but rather should be viewed as also providing technology education for the users and feedback for the developers and planners.

THE PROCESS OF TECHNOLOGY DEVELOPMENT AND ABSORPTION

The application of technology for military use, when in the development process, proceeds at different rates along these parallel streams: doctrine, organization, and material. These three streams merge in the

*This is not to overlook the all too familiar phenomenon of a solution looking for a problem or the equally familiar case of systems developer advocacy. These are separate but similar problems in identifying innovation which may or may not provide applicable and affordable alternatives to existing systems.

managerial functions of testing, evaluation, and assessment which herein will be referred to as assessments. The results of these assessments feedback into the development process and affect the formulation of modifications in equipment and changes in utilization.

Assessments are made of the applicability of particular technology developments to established goals or perceived needs, both in the narrow technical sense of specific performance objectives and in the broader sense of meeting battlefield objectives and furthering the development of military capabilities.

Underlying the three-part development stream and the assessment process are many national historical, cultural, technological, and institutional factors. These factors are pervasive, slow to change, and difficult to isolate. They range from cultural and historical factors shared by the society as a whole and permeating civilian as well as military institutions, to particular military institutional factors based on the unique military experience of a nation. Among these factors in the United States is reluctance to maintain a high state of military readiness, due in part to geographical influences and in part to social and cultural mores. In the recent years, this has been increasingly influenced by the American belief in technological superiority as a substitute for larger numbers of men and equipment and as a means of alleviating an unpalatable military burden. For the Soviet Union contrasting factors are the beliefs that it must be prepared to fight a war on or near its homeland and to overcome historical enemy technological superiority.

The Soviets tend toward technological developments that support the objectives and operational concepts of their military doctrine as defined from the top; the highly centralized leadership has relatively tight control of research and development and of production. There is a great degree of stability in military leadership, with little turnover of high-level personnel. In the United States there is greater turbulence in leadership and its control of these processes and developments tend to be oriented more towards alleviating technical deficiencies than toward contributing to a stable set of requirements. Development of doctrine often lags development of materiel, and sometimes both are grafted on existing organizations with little attention to overall systemic implications. But the significant difference here is that in the Soviet system, top-level involvement insures that most of the institutional, operational, and organizational issues are clear or settled when the acquisition decision is made; whereas in the United States system, many of these issues still lie ahead when the acquisition decision is made.

Because of such differences, military equipment development and employment differs in the United States and the Soviet Union. Policymakers and military leaders of the two countries perceive war differently, both in terms of the nature of the battlefield and the means by which battlefield objectives can be realized. These diverse national bases affect how the three parallel streams operate by providing the inputs for technological change, determining the initial operating state of the military development establishment, and affecting mechanisms for adaptation and change. Developments which are compatible with the national base and its derivative military establishment and assessment methods will be more readily incorporated than developments which clash with some aspects of the base or institutions. Since technological change today is much more rapid than the responsiveness of these institutions, advantages will accrue to the country whose ways of doing things are more compatible with such new technology.

II. EXEMPLARY TECHNOLOGIES FOR TACTICAL WARFARE

Two rather different technology areas--weapons systems and information systems--have been selected for investigation of the technological absorption process. Precision antiarmor weapons system perform a familiar function, the destruction of vehicles on the battlefield. Their development has been comparatively recent, their current level of maturity has been reached in quite a short time, and they have been tested in combat following well documented R&D assessment. They appear to have been assimilated in both Soviet and U.S. forces at about the same rate and to about the same degree. Battlefield automation, on the other hand, is a new technology area for which practical field experience is limited and the applications are still unclear. Automation systems are still in a state of rapid development and continually offer promise (not always realized) of providing expedient solutions to vexing problems of training, coordination, and the operational employment of other complex systems. Soviet and U.S. military thinkers appear to take decidedly contrasting views on how automation may be applied to battlefield functions and how the functions themselves may evolve as a result.

U.S. orientation on NATO and commitment to defense, in comparison with Soviet emphasis on the offense, provides interesting contrast to view the application of technological innovation. This suggests that different strategic drives can produce similar equivalent results in selected development areas.

These two areas of technology, antitank guided missiles and battlefield automation systems, are quite different in most ways. Yet because they are so different they are complementary in the considerations applied by the two countries in developing new military capabilities, a comparison which we seek to illuminate. This section includes brief comparative treatment of technological developments in these two areas.

(U) PRECISION BATTLEFIELD ANTITANK WEAPONS

(U) Tanks

(U) The continuous development and improvement of tank systems by the United States and the Soviet Union has received as great an emphasis as any area in land warfare technology. Because of the pre-eminence of the tank on the battlefield, many study efforts have been devoted to tank technology, and there is no need for a detailed review here.

(S) Trends in U.S. and Soviet gun systems since the early 1960s are shown in Table 1. The current basic tanks of both countries, the M60A1 and the T-62, both entered the inventory in the early 1960s. Although they differ considerably in the technology they employ, their overall effectiveness has been evaluated by many as nearly comparable, with perhaps a small advantage to the T-62 because of its smaller size.[3,4] The M60A1 tank has a more sophisticated fire control system than the T-62, providing the U.S tank with somewhat better long-range accuracy, but at the normally shorter engagement ranges to be found in Central Europe, the T-62 high velocity gun and fire control system (basically aim and shoot, with no adjustment for range) are quite adequate. These differences reflect choices in emphasis that are developed in later sections.

(U) The early 1970s saw the introduction by the United States of a small number of M60A2 tanks, employing a guided missile, the Shillelagh, and more sophisticated and complex fire control. While the Soviets may have experimented with guided missiles as main armament on tanks, they did not choose to develop such a system. The United States has essentially abandoned the idea as well, with the introduction of only about 500 M60A2s into the inventory and no serious effort to develop another such system in prospect.

(S) In the late 1960s and the early 1970s both countries turned toward the incorporation of improved technologies into modified tanks (the U.S. M60A3) and new systems--the XM1 and its abandoned predecessors for the United States, and the T-64 and T-72 for the Soviets. As noted in Table 1, these tanks use major improvements in technology

(U) Table 1

(U) TRENDS IN PRECISION GUN SYSTEMS

SECRET

United States	USSR
1960s	
M60A1 -- 105-mm gun; fire control for accuracy	T-62 -- 115-mm gun; high velocity; accurate round at short ranges; small profile; large numbers
1970s	
M60A2 -- guided round; advanced fire control; small number M60A3 -- improved fire control; faster, more lethal main round; improved mobility	T-64, T-72 -- 125-mm gun; combustible ammunition; 3-man crew; automatic loader; improved mobility; fire control modernized; small profile; large numbers
1980s	
XM1 -- composite armor to defeat shaped charge round; some with 120-mm gun; improved penetration; new engine; improved mobility; reduced profile New tanks -- smaller vehicle; 75-mm rapid-fire gun	New tanks -- composite armor; new main gun round; greater weight

for fire control, mobility, ammunition, and armor. In the past, new tanks have been developed more to take advantage of improved gun technology. The Soviets have fielded their new generations of tanks before the United States with about a five-year lead (1975 for the T-70 compared to 1980 for the XM1), and with far greater numbers anticipated. The Soviet emphasis on high rates of production is seen clearly in Table 2, where the estimated inventories of major tank systems is given The Soviet annual rate of production (3000 to 4000 tanks per year) is so high that they produce a number equivalent to the U.S. inventory of modern tanks in about three years. They typically produce over 20,000 tanks of each type, as seen in Table 3. As will be discussed later, this emphasis on producibility permeates thier weapon development system.

(U) Table 2

(U) ESTIMATED INVENTORY OF U.S. AND SOVIET MAIN BATTLE TANKS

SECRET

	1977	1980	1985
U.S.			
M60	6,600	9,200	9,900
XM1	0	60	2,950
Soviet			
T-62	15,000	12,500	9,000
T-64, T-72	6,500	16,000	25,000

(U) SOURCE: Unofficial estimates based on discussions with representatives of U.S. Army and Defense Intelligence Agency, October 1977.

(U) Table 3

(U) ESTIMATED SOVIET TANK PRODUCTION TOTALS

SECRET

Type	Number
T-54	33,300
T-55	25,100
T-62	21,900

(U) SOURCE: Unofficial estimates based on discussions with representatives of Defense Intelligence Agency, October 1977.

(U) Antitank Guided Missiles

(S) The advent of infantry antitank guided missiles (ATGMs) in the late 1950s opened a new era in armored warfare, although the use of ATGMs in battle did not occur until the Vietnam War, and, more significantly, in the Yom Kippur War in 1973. Many predictions have been made of the demise of the tank due to precision-guided weapons developments. The Israelis suffered high losses of tanks to ATGMs at the outset of the war, but quickly changed their tank employment tactics and adopted countermeasures that resulted in reduced ATGM effectiveness. Of the 600 to 800 Israeli tanks destroyed or severely damaged, an estimated 6 to 24 percent of the losses were attributed to ATGMs, with most of the rest attributed to Arab tanks[(5)]. The Israelis themselves employed no ATGMs during the war, relying almost entirely on their own tanks to deal with Arab tanks. Thus there is little wartime experience to support ATGM preeminence and the balance between armored vehicles and antitank guided weapons remains a controversial subject.

(S) Three distinct eras of development in ATGMs for the United States and the Soviet Union are shown in Table 4. ATGMs introduced in the late 1950s were manually guided by flight corrections provided to the missile as a result of the operator visually tracking both the target and the missile. Such a guidance system is difficult for the operator to manage, and operator proficiency comes only from continued practice, as the Soviets have provided with frequent training on SAGGER simulators. Although this guidance system was rather primitive, the Soviets acquired these missiles, particular the Sagger, in large numbers. An estimated 400,000 Saggers and an estimated 30,000 Swatters had been produced as of October 1977[(6,7)]. These missiles are manportable or employed on a variety of helicopters.

(S) In contrast, the United States did not make a serious commitment to comparable first generation ATGMs, but chose to wait for semiautomatic systems, primarily the TOW and Dragon, before procuring large numbers. Semiautomatic systems are much easier to operate, with automatic tracking of the missile while the operator visually tracks the target. The difference in operability can be appreciated when

(U) Table 4

(U) TRENDS IN ANTITANK GUIDED WEAPONS

SECRET

United States	USSR
Manual -- 1960s	
SS-11, Entac -- small numbers; not mounted on vehicles	Swatter, Sagger -- large numbers; mounted on BRDM, BMP, BMD vehicles, and Hind, HIP helicopters (1970s)
Semiautomatic --1970s	
Shillelagh -- small numbers; higher velocity; mounted on M60A2 and Sheridan vehicles	Uprated Swatter, Sagger -- adaptation of manual version; Swatter probably has IR homing
TOW -- large numbers; M113, Cobra, ITV vehicles	Spigot, Spandrel, Spiral -- new; higher velocity; tube-launched; extended range
Dragon -- portable	
Automatic --1980s	
Laser-guided -- high velocity; longer range; Hellfire for helicopter launch (AAH); Copperhead for artillery launch	Laser guided -- helicopter launch; high velocity; longer range
Other -- Terminal homing; laser beamrider (semiautomatic)	Hybrid guidance -- initial command link; terminal homing
	Fully automatic guidance

one considers that operators can learn to employ TOW and Dragon with reasonable success in a matter of days, compared to many months of training on a simulator for Sagger before live firing is permitted[6]. The TOW missile has been employed on the M113 armored personnel carrier and the Cobra attack helicopter, and modifications to the M113 are resulting in the Improved Tow Vehicle (ITV). The Dragon is operated as a man-portable system.

(C) It had long been thought by many that the United States held a significant lead over the Soviets in the technology for ATGMs. It has now become apparent that this lead was never so great; semiautomatic guidance for ATGMs had been developed by the Soviets in the late 1960s, starting with modifications to Sagger and Swatter. Three newer systems, the Spigot, Spandrel, and Sprial, were fielded at about the same time as their western counterparts. The production rates for these new Soviet missiles are unknown so that the fraction of modern ATGMs in the Soviet inventory is unknown. The man-portable Spigot is probably also employed on the BMP and BMD. The Spandrel, seen on the BRDM-2, could also be adapted to helicopter employment. The Spiral has been observed on the advanced HIND-D helicopter.

(C) New third generation guidance developments in ATGMs are evident for both the United States and the Soviet Union. In the U.S. case, the main programs are the Hellfire missile with semiactive laser terminal homing to be used on the Advanced Attack Helicopter (AAH), and the Copperhead artillery launched projectile with semiactive laser homing. Both of these missiles can be used at considerably greater ranges than current ATGMs and have higher velocity. In addition, there is a modest effort to develop systems with improved guidance compared to TOW and Dragon. Laser beamrider guidance has received some emphasis, although it is still a semiautomatic system requiring the operator to track the target.

(S) The Soviet ATGM development program appears richer in its variety and more vigorous in its pursuit than the U.S. program. A system with semiactive laser terminal homing probably will be fielded for use on ground vehicles and helicopters, perhaps before the United States fields Hellfire on the AAH. Several other new systems are believed to be under development. Missiles with hybrid guidance, using a terminal seeker in conjunction with semiautomatic command guidance, are likely to be available in the early 1980s. The Uprated Swatter is an early version of a missile with hybrid guidance. Missiles with fully automatic terminal homing may appear in the mid- to late-1980s, in which case they would be fielded before comparable systems are deployed by the United States. A new heavily armored tank destroyer vehicle, Drakon, with either Spandrel or Spiral ATGMs may be fielded soon as a replacement for the more vulnerable BDRM-2.[6,7]

(U) There has been a difference in emphasis between the United States and the Soviet Union in the usage of ATGMs. The Soviets not only fielded large numbers of ATGMs earlier, but they also integrated them with vehicles such as the BRDM and BMP in the 1960s to support their concept of highly mobile ground warfare. In contrast the original U.S. emphasis was primarily as infantry weapons to be used by crews or individuals not fighting from vehicles,* and often in a contingency or secondary role. By the mid-1970s, as appreciation grew of the potentially high intensity of warfare in Central Europe, the United States began to place greater emphasis on incorporating ATGMs into vehicles, as the Soviets had done nearly a decade earlier, and on providing some degree of protection for ATGM operators from infantry and artillery fire. High priority was given to improving the configuration for TOW on the M113 vehicle. The design for a new infantry fighting vehicle which had been under development since the 1960s, was modified to incorporate ATGMs as an integral weapon system. As late as the mid-1970s infantry fighting vehicles were still being configured without any antiarmor capability.

(S) The other significant vehicle for employment of ATGMs is the attack helicopter. In this area, there has been a long delay by the United States, in developing such a system since its early trial usage in Vietnam. In the meantime, the Soviets experimented with and fielded the HIND and HIP helicopters equipped with ATGMs and other armament. The HIND, designed from the beginning primarily for the attack role, is a more sophisticated and capable attack helicopter

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*(U) The Shillelagh, procured in small quantities, is employed on vehicles.

than the U.S. Cobra; several different ATGMs are used, and new missiles are being developed that can be used with HIND. In contrast, the United States considers the AAH as its first helicopter designed specifically for an attack role, and ATGM improvements are designated for usage on AAH rather than Cobra.

(U) BATTLE MANAGEMENT AUTOMATION SYSTEMS FOR GROUND FORCES

(U) The use of computer systems and automation technology has become extensive throughout American society in recent years. The United States appears to lead the Soviet Union by 5 to 10 years in most of these technologies and perhaps by a great deal more in their widespread utilization in society. The use of such technologies for military applications is also becoming widespread. Complex weapons systems depend on computers for a variety of functions, such as fire control; large data system management, particularly for personnel and logistics functions, has profited greatly from the employment of computers. Although to some extent the management of air and naval warfare has been aided by automation (e.g., air traffic control systems), land warfare is still managed largely without computers, commanders using voice communications and manual calculations and situation assessments. The influence of automation on battle management is likely to increase significantly in the next decade for both the United States and the Soviet Union.

(U) U.S. Developments

(U) The only battlefield automation system actually fielded by the United States for ground combat operations is the FADAC system for performing technical fire control calculations for artillery fire. First put into operation in 1964, this system is obsolete, unreliable, and generally no longer used.

(U) A chronology of the initiation of development of U.S. automation systems is shown in Table 5.[8] These developments have been oriented around the use of off-the-shelf computers, the technology for which has changed so rapidly that immediate obsolescence is almost guaranteed.

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TABLE 5

COMPUTER SYSTEMS FOR AUTOMATION OF U.S. ARMY GROUND COMBAT OPERATIONS

YEAR	SYSTEM	CURRENT STATUS
1958	FIELDATA	DEVELOPMENT DISCONTINUED
	• SYLVANIA MOBIDIC	
	• IBM INFORMER	
	• PHILCO BASICPAC	
1964	FADAC	IN USE (TO BE REPLACED BY TACFIRE)
	• M-18 GUN DIRECTION COMPUTER	
1967	EUROTOS	DEVELOPMENT DISCONTINUED
	• CDC 3300	
	• CDC 1700	
1967	TACFIRE	TEST AND EVALUATION
	• LITTON L3050	
1970	DEVTOS	DEVELOPMENT DISCONTINUED
	• CDC 3300	
	• DCD 1700	
1972	TOS[2]	TEST AND EVALUATION
	• LITTON L3050	

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(U) TACFIRE and TOS, the Army systems currently anticipated to reach IOC in the early 1980s, have been in development since the mid-1960s. TOS in particular has experienced a succession of program redefinitions and hardware changes. TOS is currently conceived of as a system for operation at both division level and corps level. At division level "TOS shall be a secure, militarized automatic data processing system that handles, in near real-time, the operations and intelligence information that enables a commander and his staff to effectively integrate and employ the battlefield systems which fight, support, and sustain the battle."[9]

(U) The TACFIRE system will be used for artillery tactical and technical fire control. At the artillery battalion level, TACFIRE sets will be used for making calculations to assign targets among the batteries. A computer is planned for use at the battery level to make the detailed firing calculations that were once done with the aid of FADAC. TACFIRE sets at division artillery level will be used for detailed mission planning purposes. Fourteen TACFIRE sets are being procured, 11 for use at battalion and 3 at division.

(U) The development of battlefield automation systems has been beset with management difficulties. These stem from limited continuity in personnel and programs, and lack of leadership in articulating program goals and in maintaining progress toward those goals. A chronology of the management of these programs is shown in Table 6.[9] Since 1976 there has been further change in management: a Communications Research and Development Command has been formed at Fort Monmouth and the Army staff was reorganized in 1978 with the creation of the Assistant Chief of Staff for Automation and Communications. Army responsibility for battlefield automation is currently divided among these two organizations noted above, the Electronics R&D Command, the Center for Tactical Computer Systems, and the various project managers under DARCOM.

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TABLE 6

HISTORICAL DEVELOPMENT OF U.S. ARMY AUTOMATION OF GROUND COMBAT OPERATIONS

1955	USCONARC INITIATED TACTICAL AUTOMATED DATA SYSTEMS PROGRAM: APPROXIMATELY 100 SEPARATE ADP APPLICATIONS IDENTIFIED AND STUDIED.
1961	MASTER PLAN FOR THE COMMAND CONTROL INFORMATION SYSTEM – 1970 (CCIS-70) PUBLISHED BY DCSOPS. PROVIDED FOR INTEGRATED APPROACH TO INTRODUCTION OF AUTOMATION INTO THE FIELD ARMY.
1962	CCIS-70 PROGRAM PLACED UNDER PROJECT MANAGEMENT OF USAMC.
1963	DA GENERAL STAFF RESPONSIBILITY FOR CCIS-70 TRANSFERRED FROM DCSOPS TO ACSFOR.
1964	REVIEW OF CCIS-70 PROGRAM. PROGRAM REORIENTED AND RESULTED IN AUTOMATIC DATA SYSTEMS WITHIN THE ARMY IN THE FIELD (ADSAF) IMPLEMENTATION PLAN. ADSAF PROVIDED FOR DEVELOPMENT AND FIELDING OF THREE SEPARATE BUT SEMI-INDEPENDENT SYSTEMS: TACFIRE, TOS AND CS3.
1964-1969	ARMY DEVELOPED EXPERIMENTAL TOS TO EVALUATE FEASIBILITY AND DESIRABILITY OF CONCEPT AT FIELD ARMY AND CORPS LEVEL. VAN-MOUNTED CDC-3300 COMPUTER TESTED IN EUROPE UNDER DIRECTION OF USAEUR/7TH ARMY. SYSTEM DESIGNATED EUROTOS.
1969	U.S. ARMY COMPUTER SYSTEMS COMMAND (USACSC) ESTABLISHED AS A RESULT OF STUDY OF MANAGEMENT INFORMATION SUPPORT (SOMISS). USACSC ASSIGNED RESPONSIBILITY FOR TOS, TACFIRE AND CS3.
1970	CONCEPT FOR INTEGRATED BATTLEFIELD CONTROL SYSTEM (IBCS) FORMULATED BY USACSC. RESPONSIBILITY FOR ARMY TACTICAL DATA SYSTEM (ARTADS) TRANSFERRED FROM AVCSA TO ACSFOR. ARTADS TO INCLUDE TOS, TACFIRE, AND AN/TSQ-37.
	EUROTOS HARDWARE AND SOFTWARE PACKAGES MOVED TO FORT HOOD, TEXAS TO SUPPORT HEADQUARTERS, MODERN ARMY SELECTED SYSTEMS TEST, EVALUATION AND REVIEW (MASSTER).

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Table 6 (cont'd)

HISTORICAL DEVELOPMENT OF U.S. ARMY AUTOMATION OF GROUND COMBAT OPERATIONS (Continued)

1971	ACSFOR ORGANIZED DOCTRINE AND COMMAND SYSTEMS DIRECTORATE (DCSD)
	DCSD ASSIGNED GENERAL STAFF RESPONSIBILITY FOR ARTADS
	ARTADS DEVELOPMENT RESPONSIBILITY BELOW DA LEVEL ASSIGNED TO USAMC
	U.S. ARMY TACTICAL COMMAND AND CONTROL MASTER PLAN (ATACCOMAP) PUBLISHED
1972	ACSFOR PUBLICATION OF LETTER OF INSTRUCTION FOR IMPLEMENTING NEW MATERIEL ACQUISITION PROCESS.
	OACSFOR TASKED TO DEVELOP, IMPLEMENT AND MANAGE A PROGRAM TO ACHIEVE ARTADS SURETY
1973	TACTICAL ADP SYSTEMS ASSOCIATED WITH IBCS PROGRAM CONVERTED TO NEW LIFE CYCLE MANAGEMENT MODEL.
1974	DA STAFF REORGANIZED ELIMINATING OACSFOR, OCRD AND OACSC-E
	DEPARTMENT OF ARMY SYSTEM STAFF OFFICER (DASSO) FUNCTIONS FOR ARTADS TRANSFERRED FROM OACSFOR TO CHIEF OF RESEARCH, DEVELOPMENT AND ACQUISITION.
	ATACCOMAP RESPONSIBILITY ASSIGNED TO ODCSOPS
	ARTADS SURETY MASTER PLAN (ASMAP) PUBLISHED
	TRADOC RECOMMENDATIONS FOR REORIENTATION OF TOS PROGRAM TO LIMIT INITIAL ADP APPLICATIONS TO SUPPORT OF DIVISION STAFF ONLY; PROVIDES FOR INVESTIGATION OF SYSTEM GROWTH POTENTIAL IN LATER PHASES.

(U) Soviet Developments

(S) Soviet developments in battlefield automation have followed a different course from those of the United States. A principal reason for this is simply the unavailability until recently of off-the-shelf computers for incorporation into automation systems, as was the case for the United States. This may not have been a disadvantage for the Soviets; it certainly has not been an advantage for the United States, judging from the lack of progress in fielding automation systems. Rather, the Soviets devoted their initial efforts, until about 1967, to formulating battlefield automation needs in coordination with battlefield doctrine, establishing centers for training military personnel in the uses of automation, and organizing a coordinated effort approved and directed by high-level authorities to develop and implement automation systems. This reflects the Soviet top-down development approach, oriented toward operational requirements, as opposed to the deficiency oriented U.S. approach. Some details of this initial phase are shown in Table 7.[8]

(S) From 1967 to 1970 the Soviets involved the Warsaw Pact with development of the Ryad third-generation computers and coordination of efforts among various countries to reach the automation goals emerging from the earlier phase of the effort. (See Table 8).[8] [redacted]

(S) Although information on Soviet automation systems is fragmentary compared to that for U.S. systems, some information on an

(U) Table 7

(U) SOVIET AUTOMATION OF GROUND COMBAT OPERATIONS--1960-1967

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First Phase, Research and Planning: 1960-1967

1955	Production of first generation computers.
1959	Scientific Council on Cybernetics established.
1960	Initial training of personnel in cybernetics, automation, and modeling.
1961	Conference at Frunze Military Academy. Results of test exercise for automation of troop control discussed. • Organization of control points • Fire control computers for missile troops and artillery • Standardization of combat and reporting documentation • Utility of TV
1962	Calls for coordinated and comprehensive automation of troop control processes. Research center for automation and mechanization for the armed forces established in CSSR.
1962-1967	Widespread efforts devoted to all aspects of military operations research; e.g., mathematical methods and modeling, programming languages, development of programs for a variety of military operations.
1964-1965	Soviet direction of Warsaw Pact studies for reorganization of C^2 structure.
1966	Establishment of research centers for automation in East Germany and Poland.

(U) Table 7 (Continued)

(U) SOVIET AUTOMATION OF GROUND COMBAT OPERATIONS--1960-1967

SECRET

Transitional Period, 1967 - 1970

1967	Soviet efforts to develop third-generation computers announced.
1968	Initial installation of third-generation computers by Soviet/WP countries
1968-1969	General staff level conferences on automation of WP forces held in Czechoslovakia and Bulgaria: efforts coordinated and tasks assigned. • East Germany: Division regiment automated field system • Poland: Territorial armies combat support system • Czechoslovakia: -- Automation of higher echelon field command systems -- Standardized computer language for WP • USSR: -- Automation of higher echelon field command systems -- Overall direction of pact efforts
1969	Joint Soviet/WP project (RYAD) to develop third-generation computers identified

automated artillery fire control system (AAFCS) had emerged.[11] [redacted] The literature on Soviet goals for artillery automation suggest that such a system, similar in concept to TACFIRE, is being developed.

(S) [redacted] some elements of battlefield automation, such as the artillery fire control system, could be operational in the near future, perhaps before comparable U.S. systems are fielded. The Soviet developments, as will be discussed later, appear more closely tied to battlefield objectives and are promoted enthusiastically at higher levels of leadership than those of the United States.

(U) <u>SOME OBSERVATIONS ON SYSTEMS APPLICATION IN THE FIELD</u>

(S) In this brief examination of two rather widely different technologies, some interesting comparisons emerge:

- o Both the United States and the Soviets have experimented with precision guided missiles as main armament on tanks. Both, perhaps influenced by concurrent developments in armor, elected to retain the high velocity kinetic energy projectile as the primary tank-mounted antitank weapon. The Soviets, however, were quick to use ATGM as auxiliary or long-range weaponry on tanks and personnel carriers whereas the United States trailed in fielding such a system by some years. This typifies the period in which Soviet doctrine called for motorized infantry to ride to and through the objective, if possible, while United States doctrine was struggling to cope with conflicting views on infantry fighting from vehicles versus using personnel carriers as a means to ride to combat. In the Soviet case, it appears that high-level decisions on mode of war fighting controlled how weaponry was developed and employed. In contrast, U.S. weaponry development seems to have proceeded at a more rapid pace than did the doctrine for its employment.

- Soviet introduction of ATGMs included procurement of large numbers of early types with applications on relatively large numbers of vehicle types. The United States on the other hand, made small commitment to early types of ATGMs and initially used them in dismounted infantry roles with few vehicular applications. Even today, with both countries at about the same level of development of ATGM sophistication, the Soviets continue to buy in great quantities and experiment with a variety of mobility combinations. The United States has fielded far fewer system types with somewhat limited span of mobility applications. One might conjecture from this that the Soviets knowingly fielded a large number of several models of ATGMs mounted in a variety of vehicles in search of the best--but most have been retained for their normal life span. This put a large number of evolutionary systems in the field simultaneously, which apparently caused Soviet logisticians little difficulty. The United States moved far more deliberately.
- Throughout the process, U.S. evaluations of ATGM system performance were driven by requirements for high kill