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to extend small unit frontages and depths. As the idea of mobile defense became established in NATO with gradual mechanization of defending divisions, increased emphasis was placed upon the mobility of infantry units. But this mobility was strictly for displacement of units from one combat or reserve position to another, *not for mounted fighting*. So time and distance factors changed, but not the conduct of combat.* The limited protection provided by the armor of the carrier was applicable only during the time of transit, not during actual ground combat.

A predecessor of TOW was ENTAC, a French-manufactured ATGM. It is interesting to note that available literature on ENTAC makes no mention of its use from vehicles, the possibility simply being ignored.(65)

There also were ingrained attitudes and branch prejudices involved; these appear to have had some significant impact on TOW mobility decisions. The TOW Qualitative Materiel Requirement (QMR) approved on 10 November 1964 stated: "<u>A firing capability from the above wheeled vehicles is desirable but should not degrade the ground mount capability from any vehicle or the air drop capability of the M-274 vehicle</u>." This is the only text sentence in the final QMR that is underlined for emphasis.**

The vehicle mounting kits that were provided were all designed for rapid dismount of the weapon for ground deployment. In the case of the M113A1 APC, the vehicle was capable of limited cross country travel with the launcher in the raised position.*** Obviously, firing and tracking from vehicles was possible only when the vehicle was halted.

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*A similar change was observed in emerging air mobile concepts wherein the infantry rode helicopters to battle only to dismount and fight on foot. Firepower did remain helicopter mobile in combat, and here we found the TOW mounted on a vehicle expressly for a firing role rather than a carrier. So also were Zuni rockets, 2.75-inch rockets, and a variety of machine guns. Even recoilless rifles were again tried on aircraft in the rush to provide airmobile firepower, while the infantryman continued to fight dismounted.

**Underlining was added by CG USACDC letter, 21 December 1965. The Deputy ACSFOR at that time was Maj. Gen. (later General) Ralph E. Haines, Jr., a prominent Cavalry and Armor officer. To him, TOW was strictly for the Infantry (the best tank killer is another tank). A former West Point English professor, he believed that the choice of words should provide desired emphasis and that underlining detracted from the scholarship and dignity of the document and its originators. The ACSFOR was Lt. Gen. Ben Harrell, an infantryman.

***Ref. 61, p. 129.

With the exception of helicopter mobility experiments, this situation continued essentially unchanged until the 1973 Middle East War. General DePuy's observation changed things rapidly: "The defending force must possess the ability to move. It must engage in an active defense of the sector. There is no such thing as digging in and waiting for the enemy to come to you."*

TOW Under Armor. Overhead armor protection for antitank weapons has a curious history. In World War II few antitank weapons other than tanks** had more than incidental armor protection. This usually was limited to a frontal shield. Even the U.S. M-10 Tank Destroyer had an open turret with no overhead protection for the crew and weapon. Antitank weapons clad in armor (heavy tanks and self-propelled guns) constituted but a small part of all antitank weapons because the industry was unable to cover all antitank artillery with armor. That is why battlefield protection for most antitank weapons from bullets and shell splinters was confined mainly to the use of ground cover and emplacement.***

Although TOW crew vulnerability had been mentioned in the QMR**** and TOW had been mounted in an APC on a retractable device, little attention had been paid prior to 1974 to overhead cover for the crew when the weapon was in firing position on a vehicle. Indeed, the developmental emphasis appears to have been on the weapon system "as a ground mounted, crew portable system."***** Lessons from the 1973 Middle East War convinced U.S. leaders that ATGMs must be mobile (more so than possible by manportage) and protected from suppression--under armor.******

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*Ref. 66, p. 32.

**The controversy over what was the best antitank weapon, a tank or a specialized antitank gun, was active during World War II even though the United States established a separate tank destroyer force.

***Ref. 67, p. 47.

****"Important factors that should be considered during the development of this and future antitank assault weapon systems are . . . the vulnerability of a gunner to enemy reaction immediately after firing the weapon."

*****Ref. 68, p. 3.

******Ref. 66, p. 33.

(U) Early in FY 1975, the U.S. Army Infantry School asked the TOW Project Manager to examine concepts then under consideration for improving TOW survivability. From this came a modified M113A1 APC called the Under Armor TOW (UAT), 37.5 inches higher than the basic M113 and 2,200 pounds heavier. This modification was judged to reduce to some degree the performance of the weapons system and had other disadvantages. This led to development of the ballistic nylon cover known as the TOW CAP, which was approved for production on 23 March 1976. IOC was January 1977.*

Little attention had been given to overhead cover for TOW during the first ten years of its life. But once the decision was made, cover was forthcoming in an interim mode quite quickly. Subsequently the Improved TOW Vehicle (ITV) was developed, permitting the crew to fire TOW from within the APC. Interestingly enough, the new Combat Support Vehicle (CSV), an unarmored TOW carrier concept, has a requirement for an armor kit to provide the maximum protection possible for the TOW system components, crew, and missile within the weight constraint of 300 pounds.**

General DePuy stated, "we are in the process of putting our antitank guided missiles on armored vehicles. In the future, we plan to put them under armor, so that the antitank guided missiles can also move with the tanks."*** At last an Infantry general, the commander of Training and Doctrine Command, firmly stated the requirement for a mobile, protected ATGM to accompany tanks in armored and mechanized divisions. It was about 15 years after the Draft QMR for TOW had been approved before the United States took seriously the TOW's mobility and its ability to operate and survive under suppressive fire.

Degradation by Smoke. Until recently, visibility suppression, or obscuration, received little U.S. attention, with only mild interest in reducing the enemy's capability to interfere with friendly mission accomplishment. Using obscuration to counter enemy activities as such got little real attention until after the 1973 Middle East War, although other countries had not similarly lost interest in smoke. British tanks

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* Ref. 61, p. 148. Such ad hoc designs for weapon mounting and vehicle integration appeared embarrassingly inferior to that of the Soviet BMP, built ten years earlier.

** Ref. 69, pp. 156-158.

*** Ref. 66, p. 33.

in World War II had externally mounted grenade launchers to provide smoke coverage for the tank's protection and escape. The United States recently adopted similar launchers and bought them from the British in 1976. The Russians put a smoke generating system on the T-62 tank, fielded in 1961, and have provided such a system for the BMP and newer tanks. The U.S. XM-1 tank will have a similar capability when fielded in the early 1980s, but no earlier U.S. production tank had this capability. Large area smoke coverage was a U.S. Army Chemical Corps responsibility, and the Chemical Corps was almost disestablished prior to the 1973 Middle East War.*

The lack of U.S. interest in or concern with the effects of smoke obscuration may be attributed to many factors, including the limited use of smoke in Korea,** decline and near disestablishment of the Army Chemical Corps, and a specialized form of warfare in Vietnam. In a 1974 visit to ground forces in USAREUR, General DePuy found little or no interest in smoke or its employment.*** Smoke modeling was not developed until after an unsuccessful attempt to use smoke in Laos in 1966, and the sole resulting model was incapable of providing useful data either of munitions requirements or of obscuration effects.**** It was still the only model in existence in 1977, a reflection of the ignorance of Soviet capabilities and the serious degradation impact on U.S. ground forces operations, including ATGM employment.

A result of this hiatus was to permit the training of an entire generation of U.S. Army officers who lacked due appreciation of the suppressive

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*The rude awakening that kept the Chemical Corps in existence was the "discovery" of extensive CBR protection in Soviet-made vehicles. Emphasis on all Chemical Corps missions had fallen to such a low level that the U.S. Army had to issue a message in February 1976 stating that the Corps was still in existence. (See *Army* magazine, September 1976, p. 58.)

**Ref. 70, pp. 80-81: "On a basis of number of missions performed and number of men employed, our smoke operations in Korea were not justifiable. The mountains and winds made close support of ground troops impossible." This estimation was for a chemical smoke generating company. Artillery, tank, and grenade-delivered smoke was widely used to screen friendly activities and to signal and mark targets.

***John Kramer, "Welcoming Address," Smoke/Aerosol Working Group (SAWG), Joint Technical Coordinating Group for Munitions Effectiveness (JTCG/ME), 15-16 February 1977 meeting notes.

****Ibid. See also Ref. 71.

potential of smoke. During Air Assault I, an early test of the airmobile concept in 1963, the reconnaissance and mobility supremacy of the airmobile units was largely offset by extensive Aggressor use of World War II smoke pots over a wide geographic area.* Aircraft pilots and ground commanders alike found themselves severely constrained in what had previously been a relatively free-moving environment. Lacking experience, counters, and suitable alternative operational modes, the airmobile units were forced to remain stationary until the smoke cleared, permitting the Aggressor to move with almost complete freedom over a considerable distance and time. The smoke usage was considered unfair within the context of the test experiment, and smoke slid back into obscurity for another decade. Meanwhile, Soviet T-62 tanks maneuvered in Eastern Europe with smoke clouds and conducted training exercises with smoke to defeat ATGMs and degrade opponent performance.

With the high publicity accorded employment of ATGMs in the Middle East War, obscurants--especially smoke--became a hot issue. As soon as it was generally recognized that interference with the line of sight could significantly degrade ATGM performance,** extensive testing was initiated.[72] There was renewed interest in tracking systems that would penetrate smoke and increased emphasis on development of a launch-and-leave missile such as Hellfire (although Hellfire would also be unable to home on a laser-illuminated target obscured by smoke).

Obscuration was not an important item for consideration in TOW development; what consideration there was lay primarily in the field of technical functioning of the system and interrelationship of its components. Problems included selection of a flare that would be trackable in the presence of the propellant burn and other likely light sources, and one that would continue to be trackable through the exhaust plume of the launch motor.

There is no reason to believe that enemy use of smoke was ignored altogether as a possibility in TOW employment. Rather, this was treated

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*Personal recollection by Jack Walker.

**Obscuration effects on tracking (the IR source in the missile) were recognized at least as early as 1961; see ref. 63 , p.11-1.

by the developers as a doctrinal and training matter. Neither developers nor users got involved in the reality of warfare. Doctrine did not keep pace with technological development: The Army antiarmor manual in 1972 stated, "The TOW system can be effectively employed in all weather conditions, provided the gunner can see his target through the optical sight."* The developers were concerned with assembling some technological advances into a workable system that would provide an answer to the problem of killing a heavily armored vehicle at a range greater than the effective range of that vehicle's main armament.

Also to be noted is the perception in the 1960s and early 1970s of combat range of engagement as a function of terrain characteristics:

> Historically (1940-1967) the effect of terrain has resulted in mean ranges of tank-antitank combat ranging from about 300 meters in extremely rugged and difficult terrain, to about 900 meters in open, flat terrain such as deserts and coastal plains; in Northwest Europe these mean ranges have been on the order of 500 to 700 meters. There is no reason to expect that any change in tank or main armament characteristics will modify these range limitations set by terrain characteristics.**

Range degradation from existing weather and combat-related causes was not considered in the nine studies summarized by the above source.

In the face of the difficulties involved in integrating the technologies together for the entire TOW system, it seems likely that the suppressive potential of smoke, although probably recognized, was set aside as a problem of lesser importance, to be dealt with later. This attitude was partially due to lack of awareness on the part of developers, possibly augmented by advocates of this new technological development, and partially due to absence of suitable technology to overcome the shortfall. Despite the flaw, TOW was considered much better than any other concept then in development.

Perhaps something has been learned: A DT-II test has been proposed for the Hellfire missile system in a smoke environment.(75)

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*Ref. 73, p. 5.

**Ref. 74, p. VI-4.

Test and Evaluation. In the United States, testing and evaluation begin early in the acquisition process and continue throughout that process to reduce acquisition risks, to assess the military worth of the system, and to support the decisionmaking function. Two separate but sometimes concurrent tracks are followed:

> Development testing and evaluation (DT&E) assesses the technical risks of a candidate development program, demonstrates that the design and production risks have been minimized, demonstrates that the system will meet the stated specifications or characteristics, and estimates the military utility of the system.
>
> Operational testing and evaluation (OT&E) determines a system's military utility, operational effectiveness, and operational suitability. OT&E also determines the adequacy of organization, doctrine, and operating techniques, and the tactics for system employment.*

To achieve all this, testing and evaluation is today a big business.** Although currently it is quite highly structured and controlled, such was not the case when TOW was in development. The changes caused by the Blue Ribbon Defense Panel*** took effect subsequent to TOW's acceptance. Moreover, the validity of earlier modes of operational testing have been seriously challenged.(55, 78) Perhaps the key item in this context is that in the 1960s, OT&E programs *followed* the production decision (and usually only after production equipment was available).**** So the emphasis on testing TOW during the 1960s and prior to its IOC was essentially upon the system's technical design performance rather than upon its operational suitability. This fact alone helps explain such apparent oversights as the effect of smoke and the lack of overhead protection--matters which became embarrassingly apparent later, in actual field usage, as Soviet operations were accounted for to a greater extent in training and doctrine.

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*Ref. 76, p. B-1.

***DARCOM Test Facilities Register*, DARCOM-P 70-1, May 1976, and Change 1, March 1978, require over 1400 pages to summarize capabilities of DARCOM facilities and those of DoD and contractors that are routinely used by DARCOM.

***Ref 77, pp. 88-91.

****Ref. 79, p. 25.

Long-Term Developments

Among the reasons that the Soviets are able to sustain an orderly, continuous development process, as compared to the discountinuous U.S. process, is the longer time perspective of Soviet leadership. At the very heart of Marxist-Leinist doctrine is the long-term, historically inevitable struggle between capitalism and communism in which they expect to prevail. Soviet leadership and political institutions have a degree of continuity and long-term overall stability not found in the United States. For instance, the Soviets have the ability to embark on a program with very little payoff in the short term, and with very few people appreciating the long-term benefits, provided it is an effort to work on an identified problem. Through gradual education and familiarization of a wider audience, forced if necessary, acceptance is slowly gained, and, in a steamroller-like effect, progress is made.

One clear example of such a program is to provide national survival from nuclear war. In some quarters this is considered a hopeless task, but in the Soviet view slow progress can be made and some additional degree of survival can be provided each year that the effort is maintained. Similarly, the use of automation for battlefield troop control is an area where the problems that are identified require activity and progress, although in the near term a totally satisfying capability is not within reach. A caveat that should be mentioned is that a potential conflict of interests can arise if the long term effort substantially interferes with immediate goals.

In contrast, it is more difficult in the United States to generate long-term programs for which the payoff is many years hence. It has often been noted not entirely facetiously that elected officials are not concerned with problems beyond the next election. Civilians and military officers change assignments rapidly. Americans are used to solving problems quickly or rejecting the problem as unsolvable. Response to daily crisis takes precedence over attention to longer term problems. Continual rejustification of programs is required by the budgetary review process, so that achievements must be demonstratable, if not dramatic. Programs are reorganized and goals are changed to suit the style of the new managers, and most programs during their course experience a myriad of such changes in direction and management.

DOCTRINAL FACTORS AND INSTITUTIONAL INFLUENCES

Jervis[(1)] has noted a remarkable persistence in the effect of categorizing military systems with certain labels that impose a formidable barrier to their employment in unconventional but suitable modes, and to the multiple use of systems. Categorization affects perceptions; in the last section we saw how the association of ATGMs with the infantry, and the lack of mechanization of infnatry in the early 1960s, inhibited consideration of ATGMs as suitable for use by mobile, armored troops. Similarly the labeling of mines as engineer equipment, rather than as weapons, has inhibited their development and acceptance.

Jervis goes on to present numerous examples from psychological studies and historical situations of how a predisposition to view something in a particular way inhibits the assimilation of new information and the alteration of one's views on how things fit together.

> Initial incorrect hypotheses will not be quickly altered in light of later evidence but will delay accurate perception for a long time. . . . The problem is not so much that the new perception is inherently difficult to grasp, but that the established one is so hard to lose. . . . The "most difficult mental act of all is to rearrange a familiar bundle of data, to look at it differently and escape from the prevailing doctrine."

It is far easier to assimilate concepts or technology that fit directly the traditional evaluation criteria (measures of effectiveness) than to adopt new criteria or new employment doctrine. For the Soviets, multiple rocket launcher systems are a natural part of their fire support capability since powerful suppressive effects can be accounted for in Soviet evaluations. In contrast, rockets are less acceptable to the artillery branch of the U.S. Army, since the more accurate tube artillery has greater point lethality and fits better into the U.S. evaluation scheme. Only recently has the General Support Rocket System gained support for development.

(U) Soviet Employment of New Tactical Technology

(U) Several recent developments in Soviet tactical technology have come together, particularly in units for high-speed offensive operations. Karber[80] has suggested that each Soviet division will have a BMP exploitation regiment consisting of 105 BMPs, 40 T-72s, and 18 122-mm self-propelled artillery vehicles, that form the pre-eminent combined arms unit to pace a rapid Soviet offensive thrust. Mobile air defense vehicles and SA-7s would also be included in the unit. He observes that in exercises occurring in 1976 (Kavkaz and Sever) such units practiced high-speed maneuver with the support of attack helicopters.

(U) An important thing to note is that antitank weapon system carriers, the BMP and the attack helicopter, are being used *offensively* and at high-speed. The measure of success for such operations is rate of advance, not vehicle kills. This evolving employment doctrine allows ATGMs to be used suppressively. HIND and HIP helicopters, although armed with ATGMs, are also heavily armed with rocket systems and can provide suppressive fire against enemy antitank systems on the flanks of the attacking formations. The BMP can deliver a high volume of small arms fire, at least twice that of the German Marder or the prototype U.S. infantry fighting vehicle, the MICV.[81] The BMP mounts a 73-mm gun system that is effective to about 800 meters, and a complementing ATGM. The main gun provides a close-in antiarmor capability with a high rate of fire that has no parallel in current U.S. or NATO systems and is a valuable attribute for use in meeting engagements.

(S) The new 122-mm self-propelled artillery vehicles deployed preferentially to BMP regiments are in battalion rather than battery strength. The battalions also contain new armored command and reconnaissance vehicles and a BMP-like vehicle, the Small Fred, with a 37-GHz surveillance radar for target acquisition. Each artillery vehicle has its own radio.[82] The automated support system for artillery fire control has been tested only with self-propelled artillery. The formation of such a battalion, and its deployment with BMP regiments, clearly points to the preeminence of these forces in plans for Soviet offensive operations.

(S) The Soviets, recognizing the potential vulnerability of tanks and BMPs to ATGMs, were able to draw on the recently developed mobile artillery systems to provide a capability for highly responsive anti-tank suppressive fire. It is not evident that Soviet planners were sufficiently astute in the 1960s to recognize armored vehicle vulnerability to emerging ATGMs, and to develop mobile artillery as a counter. Rather, they were fortunate that their systematic emphasis on mobility throughout the ground forces resulted in equipment suitable for application to the emerging tactical needs of the middle 1970s. Usage of artillery in the direct fire mode, particularly in meeting engagements during high speed offensive operations, is further served by the time-saving features of automated artillery fire control systems. Thus Soviet doctrine has changed to take advantage of the possibilities of these new technologies and in response to the threat posed by the guided antiarmor weapons of NATO.

(U) These examples suggest that when employment doctrine accommodates a broad measure of effectiveness such as the rate of advance, overall force operations can be evaluated on a broad system basis to identify specific needs and weaknesses and a more coherent set of developments can take place. The centralized Soviet development system is well suited for such coherence. With a more fragmented system such as in the United States, and with narrower MOEs such as vehicle kills, there is likely to be a less coherent approach to problem-solving; weaknesses and deficiencies tend to be recognized and accorded priority in response to dramatic events such as the 1973 Middle East War.

(U) It has been noted by Burke[16] that technology for land warfare is leading to a blurring of the combat arms distinctions, and armor, artillery, and infantry units and equipment are becoming increasingly similar in mobility and employment. In this evolution, the Soviets recognized the shock effect of advanced armored infantry vehicles, such as the BMP, earlier than the United States did.

(U) The United States may have attempted to preserve artificial distinctions in the roles (and the equipment) of the combat arms. The idea of dismounted infantry facing a mobile, armored enemy, appears somewhat anachronistic, although arguments can be advanced that Soviet infantry would become equally vulnerable when forced to dismount from their carriers because of intolerable antiarmor fire. Still, Burke has noted that there is a "doctrinal attitude that infantry is a close, personal combat element while tanks and artillery naturally avoid physical contact and engage by standoff fire."(16)

Battlefield Computer System Goals

Both the United States and the Soviet Union are developing automation systems for the battlefield with the goal of improving the processing of quantitative information to assist commanders in allocating resources and making decisions. There are significant differences, however, in perception of what advantages can be derived from such improvements. Moreover, the impetus for such developments has clearly differed.

The Soviets have spoken of information as the third revolution in military affairs, following nuclear weapons and missiles. This characterization is a call for action by high-level authorities, and is consistent with the Soviet principle of problem identification and active pursuit toward a solution. In the development or acquisition of appropriate technology to further the underlying goals, they have pursued hybrid computer technology where appropriate, and they have sought to acquire Western technology.

The explosion of information technology in the United States in the past 20 years has taken place without such high-level direction. The impetus for its application to the battlefield has come from the technology itself, but the whole process has been treated passively at best, and often neglected or opposed. This lack of central direction, coupled with system requirements based on technical specifics that are rapidly changing, developments have been haphazard. Characterizing the situation as a technology in search of an application would not be much of an exaggeration.

Some key differences in emphasis for battlefield automation are noted in Table 12.

Soviet goals are related to their perception of problems in mounting wartime offensive *operations*, whereas U.S. goals are more

Table 12

BATTLEFIELD AUTOMATION GOALS

U.S.	USSR
More, better, more timely information for commanders	Tighter, higher-level control of high speed offensive operations
Alleviate saturation of current command and control system	Save time over manual operations, avoid delay and inaction
Capitalize on sensor and computer technology	Achieve precision and standardization under stressful conditions

directly concerned with information as a *product*. This sharp characterization of differences may be overstated, since clearly there is a connection between the quality of information available to a commander and a potential improvement in force operations. However, the Soviets establish a relationship between battlefield automation and the measure of effectiveness in operations through the quantitative factor of *time*. This provides a tremendous advantage by focusing their efforts in developing and absorbing such automation technology.

The burgeoning of sensor and computer technology in the United States has led to the realization that the military is at the threshold of being able to utilize near real-time intelligence information from beyond a commander's line of sight, derived from real-time sensors and powerful data processing, to assist in decisionmaking. This is quite profound, for the history of warfare is replete with examples where commanders have been unable to acquire the requisite information in time to change plans during a battle.

Starting with the American experience in Vietnam, there has been an expanding interest in computer processing of data derived from various target detection systems in information fusion centers where real-time battle management can be performed. A recent U.S. project, Battlefield Exploitation Target Acquisition (BETA), is using off-the-shelf computers to demonstrate how automation can help in the process of fusing sensor-derived target acquisition data. This type of approach, emphasizing the ability of automation to provide targets, seems to have greater appeal than the more vague concept of processing information to aid commanders in decisionmaking. This reflects the notion that delivery of weapons on targets is a primary measure of effectiveness applied to systems developed for U.S. ground forces.

(S) The Soviets are also likely to take advantage of sensor-derived information through data processing. Their system for automated support to SP artillery is likely to be used in conjunction with new target acquisition means to direct fire at targets more quickly. This capability seems to be particularly applicable to SP artillery battalions supporting BMP regiments. The testing and deployment of these automation and sensor systems has been concentrated in such units, and the evaluation of the automation system has been performed in terms of the time required to transmit data and fire the weapons.

(S) Although the Soviets will initially deploy automation systems similar in concept to those of the United States, they have articulated long-term goals that reflect pervasive factors in the Soviet approach to decisionmaking and military operations. They appear to be developing and employing combat models suitable for use by commanders in planning and carrying out combat operations. This usage stands in contrast to models developed in the United States primarily for peacetime analysis and as aids in evaluating weapon system effectiveness to assist in R&D and procurement decisions. Such a quantitative approach is not a recent phenomenon. Analyses of Soviet artillery officer training operations have shown(35) that since the 1930s Soviet artillery officers have been taught to think in probabilistic terms.

(U) Artillery models used by Soviet commanders expedite operations by making simple approximations and providing simple outputs based on set-piece patterns. Thus, artillery fire allocated to a specific fire mission for a prescribed period of time leads to a predictable outcome, based on previously derived empirical data (e.g., suppression of anti-tank fire, annihilation). This contributes to a principal feature of the concept--follow-on actions based on a predicted attribute of increasing the speed of decision and operations. High confidence in predicted outcomes, and the utilization of such a technique, seems to flow from the Soviet fondness for mass, in this case large numbers of artillery weapons. It reduces the dependence on information handling and communications, which in a wartime situation are likely to degrade and impose delays on offensive operations.

The Soviets hope to achieve several effects by providing automated assistance for commander decisionmaking: reducing the time for decision and, hence, speeding up operations; preventing delay or inaction, which lead to defeat; and automating routine decisions so that the commander can turn his attention to critical decisions requiring his undivided attention.

The Transition

The development of battlefield automation systems and the adoption of new modes of operations to accommodate such systems are part of a gradual long-term process. The early steps in adapting to this revolution involve the direct substitution of automation for manual functions, such as technical fire control in artillery. At the same time, as a parallel process, large-scale familiarization of officers and enlisted personnel with battlefield automation equipment and its potential uses is appropriate. There is some difficulty in familiarizing personnel, many of whom are leery of the utility of such technology in a battlefield environment or are so unfamiliar with computers and automation technology that they may be afraid to expose their ignorance.

Until the familiarization process takes place, however, it will not be feasible to make the transition to the second step in implementation of battlefield automation technology--real-time battle management using the powers of display, correlation, and prediction. Officers operating in this innovative mode will probably have to be people who essentially grew up using computers as an extension of their own analytical capability and for whom such operations feel perfectly natural, rather than people who learned to use this technology only as adults. In this respect the United States should have a great advantage, although the transition to this innovative, second step may be a decade away. The proliferation of computer technology in American society is unmatched by an comparable activity in the

Soviet society. Large numbers of officers will enter the U.S. military service with this talent, whereas the Soviets will have to deliberately provide such training.

U.S. AND SOVIET COMMAND STYLES*

The U.S. Command Style

(U) The American command style is based on the premises that:

- o Military leaders are encouraged to use imagination and creativity in making decisions and are permitted the widest possible degree of freedom to do so.
- o Tactical commanders are allowed to choose what kinds of combat information/intelligence should be collected, how they will use it, and what weight they will give to the information.
- o Initiative on the part of individual officers is encouraged.

The foundation for these premises dates back to early American history. Commanders noted for their individual styles include Generals Washington, Sherman, Lee, Grant, Pershing, Patton, and MacArthur.

The military academies have never produced sufficient regular officers to meet the needs of wartime. Both before and during the Civil War, leaders had to be recruited from civilian ranks. Popular individuals who demonstrated exceptional leadership became self-appointed "captains," who through their ability, respect, and charisma recruited men and raised units. Often the soldiers they recruited would permit only men from their own locality to lead them. They identified strongly with the region from which they came, their state, geography, type of work, and so forth. Each leader adopted his own style of command, and those he led usually approved and tried to emulate it. Washington, Lee, Roosevelt, and Jackson were highly popular citizen soldiers.

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*This section is based on the work of Ed Cesar as part of this study. (83)

After the Civil War, military leaders were provided through a regular system of merit and training, but the "free style" of command was carried on and was nurtured by the military academies and the senior service schools. During the Spanish American War, Teddy Roosevelt, and in World War I, General Pershing, although given specific responsibilities and subject to control, maintained a level of independence; they were not told how to run their commands. In World War I only U.S. officers were permitted to lead U.S. troops so that the AEF's identify was preserved. During World War II, Generals Bradley, Patton, MacArthur, and other senior military commanders adopted unique command styles and encouraged such freedom by their subordinate commanders.

In addition to the wide latitude that major U.S. military commanders have, they may choose what weight to place on the signficance and probable influence of information on current and future military operations. At a given time, one commander might give great credence to enemy morale or to the state of his logistical support, while another might attach high importance to the weather or some combination of capabilities and circumstances. Even though information is derived from the same sources or sensors, each commander assigns his own values to the information and employs it in different ways. Consequently, each major unit must be tailored to the personal style and preferences of its commander. This personal style of command tends to complicate computer software, tactical fusion, and equipment and unit interoperability. This long-term characteristic is not likely to change.

For information collection systems and information distribution networks to accommodate free-style command patterns, they must be able to adjust to frequently changing patterns and conditions. This adds to the size of computer systems and increases the informational rates of processing and display systems.

The typical procedure used for designing automated command, control, and information systems is to define a baseline for the information each commander desires or should have, as agreed by the corporate body of experienced commanders. This baseline is used to design the required sensors, associated computer software, and information networks. To use such a system, each commander, must develop a set of criteria based on his personal command style that will give him what he believes he needs, along with provisions for changing to meet new requirements. A virtue is that at least in the beginning of a combat situation the incumbent commander is familiar with the setup and knows what he should be able to receive. Provisions should be made to permit these systems to conform to changes as required; for example, to revert to a previous setup or evolve in a new direction when another commander takes over.

This need to accommodate the wide range of U.S. command styles and needs has helped to frustrate U.S. efforts to apply battlefield automation for command and control and to assist commanders in the decisionmaking process. Computers, however, have become an essential part of peacetime operations and rear area services.

The current generation of U.S. officers is management conscious. All large organizations, including the military services, require managers and formalized procedures. During the past 20 years computers have become the principal tool of management, so it is not surprising that the military has adopted computers to aid them during peacetime, and have tried to use them in much the same way to manage resources during wartime. However, their employment in battle management should be much different. Unique problems arise in battle, including a new one--the Soviets do not want U.S. battlefield computers to operate.

In *The Generals*, Maureen Nylander asserts that post-World War II generals function more as "managers than soldiers" and, as is typical of bureaucratic undertakings, represent a kind of conformity not found among their predecessors.* Conformity applied to the U.S. command style means business-like management principles and skills with emphasis on personnel, equipment, and other resources.

Ironically, alternating periods of peace and war have compounded the problem. The free-style methods of former U.S. commanders may be giving way to the more conservative style of modern-day managers; when officers assume field commands they may find machines patterned for managers, not for deciding how to fight battles. This situation may stifle ingenuity, a characteristic of commanders in which the United States has taken great pride.

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*(U) Reference 84, p. 323.

(U) As more experience is gained and new generations of commanders emerge, some U.S. commanders may interact increasingly with computer terminals; however, based on historical patterns, this will depend largely on individual style.

(U) The Soviet Command Style

(C) The Soviet command style has some of the following attributes:

- (C) o Military leaders are encouraged to make timely decisions. [redacted] While imagination and creativity are desirable, timeliness and decisiveness are of overriding significance. "Commander creativity and computer capabilities . . . should increase the effectiveness of the commander's creative activity in the process of troop control under conditions of total automation."* Druzhinin mentions the use of the computer for freeing the commander of routine decisions, "releasing commanders and chiefs from resolving the technological and noncreative tasks of military leadership" so that they can attend to more important tasks.**
- (U) o Tactical commanders are not permitted much freedom to choose what kinds of combat information/intelligence should be collected, how they will use it, or to assign arbitrary weights to the information.
- (U) o Individual initiative on the part of an officer is less important than following orders.

(U) The Soviet military mind has been molded by the World War II command experience. Most earlier commanders do not serve as current models for emulation of their styles, with the exception of Suvorov and Tukhachevski who are examples of bold, offensive-minded commanders who succeeded as a result. They are cited as models when their style

*(U) Reference 85, p. 73.

**(U) Reference 86, p. 29.

of operation fits current concepts, e.g., offensive operations with daring strikes. The mainly defensive operations of the first two years of the Soviet experience during World War II are less referred to than the offensive period from 1943 to 1945.

(C) The Soviets list the following leadership actions of a commander:

- o Making decisions.
- o Preparing to implement the decision.
- o Preparing troops for carrying out tasks.
- o Controlling the troops during the process of implementing a decision.

They assert that particular decisions are interrelated and interdependent; that a stereotyped method of combat operations will succeed only in rare instances; and that the complete responsibility for the making of a decision and for the accomplishment of an assigned combat task is borne by one man--the commander.

(U) Soviet military managers seek to encourage decisiveness and acceptance of responsibility and provide incentives for the development of these qualities. According to one interpretation, it is not certain that Soviet military managers really want or need much initiative, flexibility, or creativity among their junior officers. The Soviets define creativity as "the application of proven principles," and initiative as

> The ability to carry out an operation without needing to be told in which direction to turn. In a carefully organized and orchestrated battle, this is all that is needed. . . . In the Soviet context there is no argument about whether an officer should be a specialist or a generalist . . . the Soviet officer is a specialist.*

(U) The Soviet military commander's philosophy differs from that of his American counterpart, principally in the limits of the decisions

*(U) Reference 87, p. 128.

he is allowed to make. Although Soviet commanders are permitted, and even encouraged to use imagination and creativity in making decisions about military operations, greater emphasis is placed on their making *timely* decisions that are based on good information and less on originality. This point is illustrated by the following excerpts from Druzhinin and Kontorov:

> During the decision making process creativity plays an exceptionally important role....But to call to creativity in day-to-day life is an unjustified and harmful extravagance. It would be wrong to assume that creative inspiration is essential in all cases of decision making. *Analysis shows that the overwhelming majority of decisions do not contain anything fundamentally new or creative.* (Emphasis added.)

> The newer and more profound an idea is, the more difficult it is to accept. There is not enough obedience and discipline. A commander directs many people who are called upon to carry out his will. But before an order can be carried out satisfactorily it is necessary to understand, to sense what must be done....This takes time, of which there is never enough. The commander, when making a decision, must first consider who will implement it and how. The result depends on the decision and the quality of execution....This does not mean, of course, that a decision should be stereotyped, but it should not contain more of the unknown than is absolutely necessary. One should not abuse originality....Creative search is desirable even in simple cases, but it is not mandatory, and often impossible due to the lack of time....*Man often makes mistakes.... The first thing to do is to prevent mistakes*....This requires a method and tool....The mathematical tool provides formulated dependences, which are largely the result of generalization and experience....Thus the problem consists in formalizing a tool, which the commander and headquarters use in decisionmaking. (88) (Emphasis added.)

(U) A key idea in the above quotation is that automation can reduce human error under battle stress. One interpretation of the above is that although Soviet commanders are encouraged to be creative in their decisions the requirement is vague in its meaning. It is more important to *make decisions quickly* based on a range of options that have been previously formulated and agreed upon as

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*(U) Reference 87, p. 128.

providing the best likelihood of success under a given set of circumstances. They are discouraged (maybe even prohibited in the future, with automation) from deferring making decisions until they have better information, whereas U.S. commanders can wait.

PERSONNEL ACQUISITION AND TRAINING

(U) It was noted in Section IV that the Soviets attach a greater significance to the morale, indoctrination, and training of personnel in comparison with purely technological performance factors than the United States does. However, there has been a U.S. "rediscovery" of the importance of personnel training and crew performance, as exemplified by the analysis of tank operations on a total system basis in TRADOC's Total Tank System Study.[89]

(U) This renewed U.S. concern has gained impetus from the events of the 1973 Middle East War, in which the impressive crew performance by Israeli armor forces gave them a tremendous advantage compared to their Arab opponents.

The Average Soldier

(U) The United States and the Soviet Union face a similar problem with regard to the basic soldier (i.e., non-officer): how to train soldiers to operate increasingly complex equipment proficiently, given the relatively short time that the basic soldier stays in the active military.

(U) The Soviets, with the USSR Law of Universal Military Service of 1967, reduced the military obligation for the land forces from three to two years, in response to the demands of the civilian economy for skilled labor and young, educated men.[35] An increased burden was placed on DOSAAF, the Soviet organization for the training of youth, to provide Soviet youth with basic military knowledge and skills in order for the two-year recruits to be better prepared. Some 70 to 80 percent of Soviet inductees have received pre-induction training.

(U) Recruits are given a single assignment (e.g., T-62 tank driver), and are generally assigned to only one unit for the duration of their two-year period following their initial training. Because the service is universal, recruits have reading and technical skills that mirror those of the society as a whole. Service life is harsh; political, military, and physical training are incessant. Following active service, soldiers become reservists who are subject to prolonged periods of recall if their particular skills are needed, or if they need retraining. Because of the high turnover rate from two-year service, the Soviets have a large body of trained reservists. Goldhamer emphasizes that the American concept of voluntary military service is inadmissible to Soviet leaders, who view universal military service as an obligation to the state. Although the Soviets might prefer a larger cadre of long-term enlistees, such as the U.S. NCO force that they admire, the universality of service is a political necessity.

(U) The constant drilling that Soviet soldiers undergo is expected to result in their achieving proficiency in a particular skill. Because the service time is short, the time available to learn a particular military skill is limited, and a call for improved training methods appears in military articles and high-level speeches. The Soviet acquisition system has been noted by many to impose stringent limitations on equipment complexity in order to assure that equipment, which must be deployed in relatively large numbers, can be operated and maintained by basically ordinary soldiers. This constraint is, of course, potentially opposed to the desire for equipment performance improvements that take advantage of technological developments and require greater complexity. The Soviet approach is to have it both ways, improving equipment while strengthening training. There is always room for improvement, in their view.

(U) In comparison with the Soviets, U.S. soldiers have a longer active service, at least three years compared to two. (It should be noted, however, that a surprisingly large percentage of U.S. enlistees fail to complete their basic three years of active service.)

(U) The increasing complexity of military skills seems to some observers to be incompatible with the former two year service of draftees. Drew Middleton writes:

> A major argument within the service against reversion to the draft is that the effective operation of modern

> weapons requires experienced soldiers with high technical ability. This will be even more true in the next five years as the flow of sophisticated new weapons...increases.
>
> "You just can't get proficiency in these weapons in a year of training," a tank colonel said in Germany. "You need two, three years. Then you've got something." (90)

As their equipment becomes more complex, it is possible that the Soviets will find it increasingly difficult to achieve satisfactory individual proficiency levels, and corresponding high force readiness levels, unless they extend the length of service beyond two years.

The low skills and poor education that some U.S. recruits possess are increasingly being perceived as a serious weakness. In an article in the *Los Angeles Times*,[(91)] Morris Janowitz is quoted: "The ground forces have not been attracting a represenattive cross section of American youth. . . . The Army is failing to attract qualified youth." Although only 25 percent of civilian men and women in the military age group lack of high school diploma, more than half the recruits in the first half of 1977 failed to have a diploma.[(90)] It has become necessary to write manuals for the operation and maintenance of highly complex equipment, such as tanks and helicopters, in comic book format pitched at personnel whose reading skills are at the fifth grade level.

Vice Admiral James D. Watkins, the Chief of U.S. Naval Personnel, spoke urgently in 1977 about the implications for the Navy for having to use recruits who are so poorly educated.

> Our equipment requires routine maintenance by people who can read technical manuals; and follow precise maintenance steps. If this does not happen, the result can be disastrous and costly, he said.
>
> To illustrate his point, Watkins cited the example of an engineman who was rebuilding a diesel engine as part of a routine maintenance schedule.
>
> He could not read well and was accomplishing the process by looking at the pictures in a technical manual. When he tried to install the cylinder liners, there was no picture, so he installed them the way he thought they should be, he said.

> The engineman installed the liners upside down and it cost the Navy $250,000 to repair the engine. (92)

(U) Although military life is not always pleasant, there is a decided emphasis on making the life more attractive and providing sufficient rewards, both in money and in training, to induce soldiers both to enlist originally and then to reenlist. The potential for acquiring an education and learning skills that are transferable to civilian life are among the most attractive inducements offered to recruits. For example, the Army enlisted men specialties in computer operators, programmers, and maintenance are so attractive that higher standards can be used in selecting personnel initially. A high school degree is required, and personnel test scores are higher than the average. The big problem, however, is in personnel retention. After extensive training for these specialties, soldiers discover that their opportunities in the civilian world are far better than those in the military, and that civilian personnel in similar government jobs are much better rewarded. Even within the military, they cannot be rewarded well, and their pay is the same as low skilled personnel of the same rank.

(U) There is a real question as to whether the educational and technological limitations in enlisted personnel are accounted for when the concept of technological superiority as a counter to Soviet numerical superiority is promoted.

<u>Performance Under Stress--Training Realism</u>

(U) The Soviets come closer than the U.S. to training under realistic battlefield conditions, and they have a keener sense of the effect of the realistic battlefield on men and equipment. Training in electronic warfare environments and in smoke may go a long way toward reducing surprise in that the Soviet commander will more readily recognize the situation he faces and will have previously worked out responses in such situations. The American commander may be theoretically more flexible, but without having trained with his troops in adverse environments, his flexibility may not be translatable into a capability to operate effectively. As an example, the Soviets can navigate temporarily without radios and in smoke by using their simple vehicle land navigation equipment. U.S. vehicles have no such equipment, so that control could be lost temporarily under adverse conditions without being compensated for by flexibility.

The Soviets provide many standard operating procedures as a means of assuring uninterrupted control over their operations. This requires practice, but it is a case of practicing the same procedures over and over until everyone responds appropriately. U.S. dependence on flexibility is less conducive to improvement by training, since it inherently assumes that all the circumstnaces that are likely to arise during battle cannot be anticipated. The Soviets, despite their emphasis on standard operating procedures, have come to appreciate the need for flexibility and initiative by junior commanders, particularly in high-speed offensive operations where the situation is highly fluid. But their political and military systems do not produce such attributes in people of these ranks, and they do not get it from training.

There are institutional counterincentives for U.S. troops to train in realistic environments. The evaluation of a unit's performance would be lower if it tried to operate at night, in smoke, or through jamming, and it did poorly. This problem reflects a more general one: troops are basically prepared for peacetime operations, not for wartime. Operations are practiced against a cooperative, or at least noninterfering, threat. The assumption is made that troops will learn how to operate in wartime when they are actually at war, since historically that is how U.S. forces have acquired their real training, although most observers recognize that this assumption is clearly inadequate for the potential modern European battlefield.

Training personnel to operate under stress reflects an awareness of the realities of the battlefield and an expectation that equipment performance and personnel skills will be degraded. The training helps in assuring the authorities of a minimally acceptable level of performance. Such training is compatible with Soviet views that improvements in performance are always possible, that there is always a residual of untapped human energy that can be transformed into performance improvement through proper political motivation and military training.

Goldhamer has noted:

> Soviet training doctrine gives additional impetus to combat realism by emphasizing that under mental stress intellectual and motor abilities are subject to destructive influences, even when the stresses involved are considerably less than those that might be expected in a nuclear war. Soviet military psychologists have concluded that the first skills to suffer impairment are intellectual abilities, such as the performance of calculations and the ability to analyze and make decisions. Next comes a deterioration of motor abilities. Even the ability to drive a combat vehicle, fire weapons, and perform similar routine military duties are affected. Only experience in realistic battle situations can enable soldiers to adapt to these stresses.
>
> Although surprise alerts and similar devices provide the atmosphere of tension desired by Soviet military trainers, the principal training under conditions of combat realism and the major effort to develop psychological hardening occur in exercises and maneuvers. Combat realistic procedures are not just for occasional use, but are insisted on as an integral aspect of most exercises. It is not sufficient for an individual to be placed just once or twice in a dangerous or strenuous situation in order to become battle-hardened. These experiences need to be repeated and soldiers should, so to speak, be drilled in experiencing dangers. (35)

The Soviets attempt to inject combat realism into training by using live firing of weapons and by fooling the troops with simulation (e.g., making the troops think they are in a radiation environment). The expectation, however, is that degradation in combat performance will occur and that equipment design and operational planning factors should account for such degradations. Erickson has suggested that the Soviet emphasis on combat realism in training is attributable to the Soviet lack of major war experience since World War II.* Goldhamer suggests that in addition the Communist ideology demands that individuals must be hardened to perform under conditions of physical and emotional stress.

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*Reference 93, p. 83.

> Under conditions resembling actual combat, a soldier is afforded an opportunity to fulfill his obligation, to display honor and courage, and to demonstrate to his commanders that he has become "ideologically hardened."

Furthermore, combat realism affords the opportunity for commanders to habituate themselves to making rapid decisions under stressful conditions.

A CHARACTERIZATION OF THE PROCESSES

Production requirements enter into Soviet development procedures to a greater extent than they do in the United States. The Soviets are willing to accept design compromises at the expense of performance in order to achieve simplicity along with easy and relatively inexpensive mass production. Standardization of parts and components, limited changes in newer models, and continued use of proved components reflect a realistic view of supply unreliability from the civilian sector and a requirement for easy maintenance in the field. At the same time, high production rates are facilitated with a minimum of resource re-allocation. Design bureaus can procede at a stable rate, developing and testing components independent of demands for specific new systems. Technical risk is minimized. If a planned component for a new system fails to mature, its predecessor can be substituted. Major systems appear to be designed with the notion that subsequent modification will be made as technological development permits. The HIND helicopter, for example, has had several major modifications during its five years of operational use.

In the United States, the developmental drive is to cram as much new technology as possible into each succeeding generation of equipment. Systems are not typically designed to accomodate future changes; the 120-mm gun for the XM-1 tank is a notable exception. System simplicity and mass producibility receive little real emphasis in early design stages. The one-on-one efficiency measure is also recognizable here. But a more powerful influence is the budgetary and political rejection of the notion that systems with similar characteristics can be developed compatibly and that technological change is normal. Under such circumstances, gradual evolution over a number of basically similar equipment items is seldom possible.

(U) When entirely new technology is being developed and applied in the United States, there appears to be strong incentive for the mythology of traditional institutions to influence the paths of development. In the case of TOW, conventional armor wisdom held that the best weapon against the tank was another tank; the infantry wanted the TOW but planned to fight on foot; and no one seemed to worry about crew vulnerability to suppression or weapon performance degradation because of obscuration. Later, to give the system mobility and protection, major compromises had to be made (vehicles with high profiles, vulnerable sighting systems, and distinctive visual signatures). The obscuration problem is yet to be solved.

(U) The Soviets perceived more quickly the need to provide mobility and protection for their ATGM systems, probably because of their offensive-oriented doctrine. The SAGGER missile was smoothly integrated into the BMP vehicle in the 1960s, more than a decade before the integration of TOW into the M113.

(S) It is not evident that Soviet planners were able to forecast the full impact of ATGM development, but the broad-based development programs and fixation of mobility and speed of attack had produced simultaneously a set of self-propelled artillery. This was quickly melded with the developing BMP regiments to form a force of high mobility potential. This suggests that when employment doctrine accommodates a broad measure of effectiveness, i.e., rate of advance, a more coherent set of developments can take place. Their application can then be to meet perceived requirements on a broad systems basis rather than to shore up particular deficiencies in an incoherent fashion.

(U) There are many similarities in Soviet treatment of ATGMs and battlefield automation. The focus on time, either rate of advance or timely accomplishment of an operational task, is perhaps the most striking. The Soviets appear to be developing combat computer models for use by commanders to save time or to make better use of the time that is available by acceleration of information processing, calculation of relative merit of alternatives, and application of set formulas to combat situations such as artillery fire planning. The U.S. modeling efforts, on the other hand, are more often applied to the evaluation of weapons effectivenes and support of R&D decisions, with automated artillery fire planning capability, for example, only slowly emerging.

The next step in battlefield automation--adoption of completely new modes of display, correlation, and prediction for real time battle management--will require broad and extensive familiarization for those using or contributing input to the system. It is here that the United States enjoys a great advantage from the current widespread understanding and use of computer technology in the civilian community, although, as is apparent from the foregoing discussion, the transition to military application is not straightforward. Command style is an important and complicating factor.

And finally, many of the differences in Soviet and U.S. application of most new technology are reflected in this characterization of battlefield automation goals:

	U.S.	USSR
Information	More, better, more timely	Sufficient to select from among agreed options
Control	Technology looking for an application?	Tighter, more centralized operational control
Decisionmaking	Reduce information glut in command net	Prevent delay or inaction speed up operations
Routine (recurring functions)	Automate to speed up accomplishment	Reduce to routine to free commander for more important matters
Focus	Information as a product (or kill potential of weapons)	Timely accomplishment of operations
Model role	System evaluation and procurement decision	Planning and executing combat operations
Specific (artillery fire control)	Fire planning and follow-on based on observed outcome	Selection of set-piece patterns based on predicted outcome
System design flexibility	To fit individual commander's style	To reduce human error under stress
System complexity	Elegant solutions come from greater sophistication of gear	Simplicity leads to mass production and training ease

Personnel qualification	Train people to fit the equipment	Simplify equipment to fit capabilities of people

These observations are melded with those from preceeding sections to form the Summary at the front of this Note.

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