

Taking a Look under the Hood

The October War and What Maintenance Approaches Reveal about Military Operations

by Colonel James S. Powell, U.S. Army



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James S. Powell is a U.S. Army colonel and strategic plans and policy officer whose past assignments include tours in Iraq and Afghanistan and positions in the Pentagon as speechwriter for the U.S. Army Chief of Staff and as military advisor to the Director of Net Assessment in the Office of the Secretary of Defense. He currently serves on the U.S. Army War College faculty and has taught at the School of Advanced Military Studies in Fort Leavenworth, Kansas, as well as the United States Military Academy at West Point. Colonel Powell holds a PhD in history from Texas A&M University. His book, *Learning under Fire: The 112th Cavalry Regiment in World War II*, was published in 2010.

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Dedicated to the memory of Andrew W. Marshall, whose ideas and guidance served as the impetus and inspiration for this study.

Preface

Understanding a military competitor's logistical system and, more specifically, its maintenance procedures, has unique implications regarding how that competitor's forces frame strategic approaches and conduct operations. This historical case study analyzes logistical doctrine and performance during the 1973 Arab-Israeli War and explores how logistics and maintenance influenced the conduct of large-scale conventional operations, particularly in the Sinai campaign. The logistical shortcomings and successes that emerge help explain why Egyptian and Israeli military organizations fought as well or as poorly as they did. More important, the findings suggest what might be learned from an examination of a potential adversary's logistical system and its approach to maintenance—namely, its pattern of adaptation, its capacity for prolonged operations, how it seeks to guard against the exploitation of perceived vulnerabilities and how it might compensate for deficiencies in the technical skill of its personnel.

How the armed forces of Egypt and Israel understood the relative importance of maintenance as a factor of wartime success and how they assessed their relative strength in that area shaped their approach to strategy and military operations. Recognizing their weakness in maintenance capability, the Egyptians sought to improve technical skills in their officer and enlisted ranks following the 1967 defeat, but such efforts could only go so far in a fixed period of time. Resolved to win back the Sinai yet mindful of their armed forces' qualitative shortcomings, President Anwar Sadat and his top generals developed a plan to compensate for those shortcomings and thus minimize their operational impact. Israel, for its part, relied heavily on superior maintenance capability to address its vulnerable geostrategic position and its adversaries' quantitative advantage. In the case of both Egypt and Israel, maintenance capability also distinctly influenced patterns of military adaptation during the preparation and planning stages and in the midst of actual hostilities.

This work suggests that the U.S. military and intelligence communities should devote considerable effort toward developing a better understanding of the maintenance practices of potential adversaries in order to anticipate their overall military effectiveness and to gain insight into the kinds of operations they might pursue.

Taking a Look under the Hood: The October War and What Maintenance Approaches Reveal about Military Operations

Vast [numbers of] officers and men . . . using support methods that were relatively manpower intensive . . . made up for the insufficiency in equipment and instruments. This is a traditional characteristic of the PLA's [People's Liberation Army] logistics.

—PLA Report from a 2008 Military-Wide Logistics Academic Research Center Seminar¹

In the Middle East War of 1973 . . . it was only when the Israeli army enhanced its technical support . . . that 80 percent of the damaged tanks in the war could be recovered and sent back to the battlefields. . . . The equipment support ability of the Israelis . . . contributed a great deal to the reversal of their disadvantageous posture and changed the process and outcome of the war.

—PLA's *Science of Military Strategy*²

Introduction: The Connection between Logistics and Operations

Understanding a military competitor's logistical system and, more specifically, its maintenance procedures, can lead to useful insights about how that competitor's forces conduct operations. In turn, these insights suggest unique implications from the standpoint of strategic intelligence. The value of such a study proceeds from the close relationship between operations and sustainment. Indeed, the two are "linked," part of an "unbreakable bond" that enables decisive action, particularly in large-scale conventional operations.³ Take the realm of doctrine, for example. Operational doctrine—the body of thought that expresses an approach to war-fighting—corresponds to and generally shapes logistical doctrine. As a capstone manual, *Army Doctrine Publication 3-0* defines unified land operations—the Army's operational concept—as "simultaneous offensive, defensive, and stability or defense support of civil authorities tasks to seize, retain, and exploit the initiative to shape the operational environment, prevent conflict, consolidate gains, and win our Nation's wars."⁴ According to the concept, "the Army's

combination of expeditionary capability and campaign quality contributes to sustained land-power” in support of a joint force.⁵ The publication includes “sustainment” as one of six war-fighting functions that organize “critical capabilities . . . to achieve objectives and accomplish missions.”⁶

In this sense, logistics both supports and can be seen as subordinate to operations. Historical analysis reinforces this informal doctrinal hierarchy. James A. Huston’s magisterial 1966 study on U.S. Army logistics notes that “the primary purpose of logistics is to deliver adequate . . . fire power or shock to the critical places at the critical times for achievement of tactical and strategic objectives.”⁷ A more contemporary anthology on the same subject views logistics as “the means by which the commander achieves mass, the controlling principle of war.”⁸ Logistical means help accomplish operational ends.

To be doctrinally subordinate is, of course, not to be without influence. Shortfalls in the area of logistics undoubtedly impose certain limitations on operational capability. Current U.S. Army doctrine, for example, considers the depth and duration of operations to be dependent on the quality of sustainment.⁹ A military may well recognize its logistical shortcomings. Some of these shortcomings may be accepted as part of—or even deliberately woven into—the military’s overall concept of how it intends to fight. In any case, understanding the strengths and weaknesses of an adversary’s logistical support—to include maintenance capabilities and procedures—can shed light on how it plans to conduct operations, its actual ability to conduct them and what it perceives as most critical to achieving operational success.

Alternatively, logistical inadequacies may be entirely unforeseen. In those instances, the war continues, and military organizations must adapt. The organizations that adapt well overcome unanticipated challenges or find ways to deal with persistent problems. They may revise logistical procedures to eliminate causes of disruption. Other times, military personnel leverage their technical familiarity with platforms and equipment in order to employ them more effectively in a different way. Understanding a military’s logistical strengths and weaknesses—particularly with respect to maintenance—can also provide insight into its capacity for adaptation on the battlefield, as well as the forms of adaptation that may arise.

The utility of drawing inferences on operational practice from the quality of logistical support hinges on the relationship between the two. Lieutenant Colonel George C. Thorpe, USMC, clarified this relationship in his concise theory of logistics. Writing as a student at the U.S. Naval War College in 1917, he echoed nineteenth-century military theorists when he identified three “cardinal functions” of war. Citing Carl von Clausewitz, he viewed tactics as “the use of forces in combat.” Strategy concerned “the use of combats for the object of the war.” The third function, logistics, served an enabling role. It entailed “the accumulation and perfection of means of combat.”¹⁰

In his monograph, Thorpe went on to argue for a revised conception of logistics and a broader definition of the term. Logistics was a “distinctive branch” consisting of many wide-ranging but interrelated activities. Not only did logistics require deliberate coordination with the parallel efforts of tactics and strategy, but it also demanded a holistic approach.¹¹ Military professionals could not expect to meet with success while treating logistical support as a set of discrete “stovepipes” (to use modern parlance). Nor could they consider it an afterthought in the planning process—a group of issues casually consigned to the realm of “neither tactics nor strategy.”

To highlight both the significance and uniqueness of logistics, Thorpe likened the relationship among the three cardinal functions of war to the production of a play: strategy was comparable to the plot; tactics represented the role of the actors; and logistics furnished “the stage management, accessories, and maintenance.” It came as no surprise that logistics was underappreciated: “The audience, thrilled by the action of the play and the art of the performers, overlooks all of the cleverly hidden details of stage management.” Nonetheless, Thorpe asserted that “the part played by the stage director, the scene-shifter . . . and the lighting expert equals, if it does not exceed in importance, the art of the actor.”¹² Regardless of whether one takes Thorpe at his word, it is enough to say that the quality of logistics—in its supporting or enabling role—holds tremendous sway over the outcome of conflict; there is a connection between how armed forces intend to wage war and how they plan to sustain themselves during such contests. What is more, from a strategic intelligence perspective, this connection can be exploited and used to improve understanding of potential adversaries.

This essay analyzes the logistical doctrine and performance of competing militaries in war and explores how logistics and maintenance influenced the conduct of operations in the case of the 1973 Arab-Israeli conflict. The logistical shortcomings and successes that emerge from this study help explain why the military organizations in question fought as well or as poorly as they did. More important, this essay suggests what might be learned from an examination of a potential adversary’s logistical system and its approach to maintenance—namely, its pattern of adaptation, its capacity for prolonged operations, how it seeks to guard against the exploitation of perceived vulnerabilities and how it might compensate for deficiencies in the technical skill of its personnel.

Background: Israeli and Arab Maintenance Performance in the 1973 War

The October War was the fourth in a string of conflicts fought between Israel and its Arab enemies. It followed the Israeli Defense Force’s (IDF) decisive victory of June 1967, in which Israel wrested control of the Sinai Peninsula from Egypt. Reluctant to concede this loss, the Egyptians began almost immediately to prepare for their military’s eventual return. The blow that fell on 6 October 1973 struck a tremor of surprise in Israel and sent the IDF scrambling to hold back the Arab tide, north among the Golan Heights and south along the Suez Canal. In an assault timed to coincide with Syria’s northern offensive, the Egyptians surged into the Sinai on a wide front and established several shallow bridgeheads under the protection of mobile air defenses. Israeli armor mustered quickly for a counterattack, but it met swarms of infantry equipped with antitank guided missiles. Staggering losses in the air and on the ground shook the IDF to its core.

After one week, however, the Egyptians attacked toward the Sinai passes in order to relieve pressure on their struggling Syrian allies. In doing so, they ventured beyond the protection of their air defenses and deviated from the carefully scripted plan that had thus far brought success. This development set the stage for another counterattack by a reconstituted (and far wiser) IDF. Israeli tanks pushed across the Suez Canal into Africa and were well on their way to cutting off half of the Egyptian assault force before the United States and the Soviet Union stepped in to impose a ceasefire on 28 October.

Compared to its Arab opponents, Israel receives high marks for its maintenance performance, despite an admittedly rocky start. The IDF emphasized technical and tactical competence in its tank crews; this effort positively affected both gunnery and equipment upkeep. Drawing

on their high levels of technical skill, crews fixed most minor mechanical problems themselves. Sensitive to Israel's quantitative disadvantage in armor, the army possessed a robust recovery capability and thus minimized the impact of breakdowns and battle damage by repairing combat vehicles relatively quickly and then returning them to the front.¹³ For its part, the Israeli Air Force kept more aircraft in action than its Arab counterparts. Ground crews were organized to repair and service planes with impressive speed and efficiency, resulting in a higher turnaround rate and allowing the Israelis to conduct more sorties per day despite having fewer aircraft.¹⁴ Though crucial in helping to offset unexpectedly high aircraft and armored vehicle losses suffered in the war's opening days, the U.S. airlift in support of Israel was not especially timely. The promise of forthcoming assistance allowed Israeli leaders the flexibility to commit reserve stocks of equipment and ammunition to meet the crisis, but the arrival of U.S. military hardware occurred after the tide had turned decisively in Israel's favor. Until then, the IDF was on its own.

To be sure, Israel's logistics and maintenance record from the war was far from perfect. For example, since 1967, its depot system had been allowed to decline. Hence, over 300 reserve tanks—and nearly one-third of that number in the regular forces—were without their combat loads when Egypt and Syria attacked. Tank breakdowns amid the rushed deployments to the northern and southern fronts compounded these mobilization issues and added to the friction associated with recovering from surprise and organizing for battle.¹⁵ In his account of the 1973 war, journalist Edgar O'Ballance elaborates on the IDF's shaky start and cites this unpreparedness as a springboard to question its comparative military superiority. Still, even he admits that Israel maintained a distinct—if diminishing—technical and qualitative edge over its adversaries.¹⁶

Aspects of the Arab militaries' wartime logistical performance were adequate—even excellent—but maintenance was notoriously subpar. As a case in point, Egypt's military moved over 800 tanks and 90,000 men across the Suez Canal in less than three days and continued to flow substantial reserves to the front for much of the war. Its quartermasters supplied this force with minimal disruption until just days before the ceasefire (when the IDF effectively cut off the Third Army).¹⁷ A remarkable logistical feat in its own right, the crossing itself reflected detailed planning, engineering acumen, ingenuity and an aptitude for delivering surprise—shattering Israeli estimates for the time required to breach the fortified defensive line along the canal's eastern bank.¹⁸ Nonetheless, solid performance related to the supply and movement of sizable combat forces stands in stark contrast to what one commentator has called “shoddy maintenance practices.”¹⁹

Prewar cases of notable equipment failure indicated long-standing maintenance problems in Egypt's military. During the 1956 Arab-Israeli conflict, an Egyptian destroyer shelled the coastal city of Haifa. Later, crewmembers attempted to scuttle the ship in order to prevent its capture by two Israeli vessels in pursuit, but the valves that would have allowed water to flow into the hull had rusted shut. Likewise, in 1970, the landing gear on the airplane transporting Egypt's president functioned improperly during three successive landings thanks to excessive rust.²⁰ Both failures stemmed from inadequate preventive maintenance. What is more, the latter case throws suspicion on the institutional ability to diagnose and fix a *known* maintenance issue.

That certain Arab armies categorized up to 70 percent of their armored forces as “non-operational” during prewar alerts did not surprise observers of Middle Eastern military affairs.²¹ By and large, officers and men gave short shrift to the routine care of equipment. A meager

supply of technical skill spread thin across combat units exacerbated this pervasive apathy toward maintenance. Even minor faults often required the evacuation of a vehicle or weapon system to a centralized depot, where trained mechanics—usually foreign—repaired them. Appalling readiness rates were the result, with rates of 25–30 percent more common than the 70–80 percent rates often seen in modern armies.²² Regardless of the underlying reasons, it was no secret that inefficiency and low standards of performance characterized the maintenance systems of Arab forces in general and of Egypt’s in particular.

The 1973 October War confirmed the poor state of maintenance in the Egyptian military. Substandard service and repair practices slashed the air force’s quantitative advantage, rendering 35 percent of its fighter fleet unfit for combat operations and accounting for a paltry average of 0.6 sorties per aircraft.²³ The army fared no better. Despite their reputed ruggedness, the Soviet-made tanks in Egypt’s arsenal were not immune to the effects of inadequate maintenance under conditions of sustained combat—particularly in the desert. Ten days into the war, about 80 percent had broken down.²⁴ The inclination of Arab armies to abandon damaged vehicles rather than recover and repair them likely compounded this misfortune.²⁵ In their meticulous technical study of the 1973 conflict, analysts Anthony H. Cordesman and Abraham R. Wagner found that “repaired tanks represented an important element of combat strength” and that this particular metric overwhelmingly favored the Israelis.²⁶

Operational accounts tend not to mention heroic maintenance-related achievements, but hints of IDF competence in this area support Cordesman and Wagner’s claim. For example, military historian Trevor N. Dupuy notes that, in blunting Egypt’s 14 October advance, the Israelis lost 40 tanks and that “all but six were soon back in action.”²⁷ Likewise, Bren Adan, an Israeli division commander, refers frequently to vehicle recovery and repair efforts in his chronicle of the Sinai campaign.²⁸ One has trouble finding similar anecdotes on the Egyptian side.

Arab Culture and the Implications for Maintenance Performance

Despite evidence for what appear to be clear systemic Arab military weaknesses, Western scholars have struggled to explain them in a way that avoids charges of ethnocentrism. Michael J. Eisenstadt and Kenneth M. Pollack explicitly link poor battlefield performance with culture in their analysis of Egyptian, Syrian and Iraqi combined-arms operations. They argue that the ubiquitous failures of tactical leadership in Arab armies stem not from socioeconomic underdevelopment or dysfunctional civil-military relations but from patterns of behavior generally found in Arab culture. Distinctive traits, such as a tendency to conform, excessive deference to authority and shame avoidance, shape the collective behavior of Arab military officers and enlisted men just as they do broader Arab society. According to Eisenstadt and Pollack, these influences have produced a set of consistent military shortcomings. In the fluid wars of maneuver that Arab states have fought with Israel since 1948, the most crippling consequence of culture has been a lack of junior officer initiative and adaptability.²⁹ While withholding judgment on specific cause-and-effect relationships, historian John A. Lynn supports this notion that civil values serve as the bedrock of military culture.³⁰ If Arab culture has had an impact on operational effectiveness, can the same be said about maintenance?

The answer is largely unsatisfying. Pollack, for one, refuses to generalize about Arab culture and its effect on maintenance practices in Arab armed forces. In his exhaustive study of Arabs at war, he cites evidence of logistical excellence on one hand and abysmal maintenance performance on the other. Pollack labels this an apparent contradiction, noting that transportation

and supply call for skills not unlike those required to keep equipment in serviceable condition. Sifting through the puzzle, he reluctantly concludes that the pieces simply do not fit.³¹ Middle East scholar and retired U.S. Army officer Norvell B. De Atkine offers an admittedly tenuous path forward. He dismisses the canard that Arabs “don’t do maintenance” and argues that their difficulties stem from a failure to grasp the American concept of weapon systems. “A weapons system,” De Atkine explains, “brings with it specific maintenance and logistics procedures, policies, and even a philosophy, all of them based on U.S. culture, with its expectations of a certain educational level, sense of small unit responsibility, tool allocation, and doctrine.”³²

Setting aside De Atkine’s assertion that the concept itself is an American invention, a weapon system not only requires multiple components to function well and work together but also demands from its crew a mindset that enables successful and consistent employment. Given these stipulations, one can appreciate how the distinctive traits of Arab military culture may run counter to conducting effective maintenance. For example, deliberately avoiding shame stands in opposition to accepting responsibility.³³ An unwillingness to acknowledge problems and take responsibility for solving them grinds against the practice of delegating decisionmaking authority to subordinate organizations. This has negative consequences for maintaining equipment in military units—especially under the strains of combat. Geared toward repairing materiel at the lowest level, the maintenance system of U.S. armed forces depends for its responsiveness on a liberal delegation of authority and a corresponding degree of access to spare parts and tools. De Atkine, who spent part of his career as an advisor to the Egyptian army, found that tools normally allocated to an American battalion were typically unavailable at the same echelon (or even one or two levels higher) in Arab militaries.³⁴ Why would a commander provide tools and authority to a unit on which he could not rely and to a leader who, in any case, did not savor additional responsibility?

Along these lines, extreme deference to authority—another Arab cultural trait—dampens initiative in subordinates while a preference for conforming to group norms has the effect of stifling innovation and independent thinking.³⁵ Not inclined and perhaps unable to do more than what was required to fix equipment in the first place, subordinate leaders were even more unlikely to discover and implement novel maintenance solutions. In De Atkine’s experience as a military advisor, the equipment itself took the blame for its own persistent malfunctions: it was deemed “too delicate” simply because its crew lacked the ability to fix minor damage or routine maintenance faults.³⁶ Thus, prevalent behavioral patterns, such as a “trust” deficiency in relationships and a low appetite for creative risk-taking, seem to work against the formation of an effective “maintenance culture” in Arab military organizations.³⁷

Though based on anecdotal evidence, this cultural explanation for the uniformly poor conduct of maintenance in Arab armies is plausible. Consider one alternative to the cultural explanation: pinning the blame solely on the deficient technical skills of vehicle crews and mechanics. This may appear straightforward. Yet Egypt took dramatic steps to improve personnel quality in its military prior to 1973. By itself, sheer technical incompetence seems less than compelling as an explanation for lackluster maintenance performance during the October War. It is more reasonable to argue that even major advances in training and education were not enough to overcome the maintenance-related limitations rooted in Egyptian military culture, itself an extension of civilian culture. All the same, *why* these shortcomings existed is perhaps not as important as the question of *how* they affected operations and warfighting. Given the maintenance record of the two belligerents of 1973’s Sinai campaign, what inferences can be drawn?

Egyptian Improvement: Boosting Education Levels in the Armed Forces

Egypt's civilian and military leaders recognized the limitations under which their forces labored and dealt with those weaknesses, in part, by addressing them head on. After the staggering defeat of the Six Day War, Egypt came to view its longtime peasant-based army as ill-equipped to handle the challenges of fast-paced mechanized battle and so dramatically altered its military's demographics. Although the rank and file in 1967 consisted almost entirely of rural villagers with little personal exposure to modern communications and transport, by 1973 about one-quarter of it came from urban areas.³⁸ This modest leavening of the force with technically savvy recruits was boosted by a rise in education levels. From 1967 to 1973, the percentage of high school graduates in the military doubled from 25 to 51 percent, and more than one in eight soldiers in the army's ranks had university degrees. For officers, the proportion of college graduates grew to 60 percent, up from a mere 2 percent in 1967.³⁹

This deliberate effort to conscript better-educated young men (and especially those with technical backgrounds) signified a notable acceptance of risk for the regime. Before the 1967 war, President Gamal Abdel Nasser had banned many students from military service, broadly judging intellectuals as too politically unreliable as a class. Yet, prior to his death in 1970, he essentially reversed this policy with a decree that all tank commanders and officers in charge of electronic equipment be graduates of an engineering or technical school. In fact, as a testament to how highly the leadership valued their expertise, half of the engineers in Egypt were serving in the armed forces by the fall of 1973.⁴⁰ The influx of those with college experience not only raised the education level of the officer corps but, as stated earlier, had a similar effect on the rank and file. Many students and graduates drafted into the military passed up the opportunity to earn a commission and settled instead for the enlisted man's much shorter service obligation.⁴¹

Did improving education levels in the military compensate for the sparse manifestation of maintenance and maintenance-related experiences in Egyptian daily life? Did more college degrees in the ranks necessarily translate into personnel skills that begot higher equipment readiness rates? It is, of course, hard to assess the real impact of these measures on operations. Nonetheless, their implementation attests to the Egyptian high command's seriousness when it came to improving personnel quality in the armed forces. The technical bent that characterized this effort also gave some indication of the priority placed on the proper functioning and employment of weapons and equipment and, by implication, suggested a renewed concern for maintenance.

Egyptian Improvement: Soviet Assistance Following the Six Day War

In the aftermath of the 1967 rout, Egypt also looked to the Soviet Union for help. Like the Egyptians in their competition with Israel, the Soviets acknowledged a shortfall in secondary education and technical proficiency compared to their Cold War adversaries. By the 1960s, this gap had closed somewhat, but Soviet efforts to close it reflected an acceptance of the mounting significance of soldier quality in modern war. "Of themselves, weapons and military equipment do not determine the success of combat operations," wrote one U.S.S.R. defense minister. "What is important is in whose hands they are. . . . Neither a missile, nor a plane, nor a tank—nothing is so formidable for the enemy as a soldier who has high combat morale and military expertise, who is capable of skillfully employing weapons and equipment and using their combat properties to the full extent."⁴²

The connection between rigorous, realistic training and high troop quality was plainly evident,⁴³ but the Soviets also viewed *education levels* across the available pool of conscripts as germane to rank-and-file expertise. The same senior defense official noted the “profound socioeconomic, spiritual and cultural transformations” that had occurred in post-World War II Soviet society and anticipated the impact that such improvements would have on the armed forces: “The considerable growth of the general educational and technical level of Soviet youth and their high moral-political and physical preparation permit them to master a military specialty, weapons and combat equipment in shorter periods of time.”⁴⁴ To the Soviets, success at the tactical level of war stemmed from soldiers’ “excellent mastery of the complex combat equipment at their disposal.”⁴⁵ This required technical proficiency, a product of “higher, secondary and professional-technical education.”⁴⁶ As U.S.S.R. involvement in the Middle East deepened following the Six Day War, the logic underpinning the connection between tactical success, equipment mastery and education likely influenced Egyptian policy. In enacting the personnel reforms described in the previous section, Cairo probably had some encouragement from Moscow.

Given the Soviets’ extensive engagement with the Egyptian military that fought in 1973, it is worth mentioning the key factors that informed this influence. Despite a deliberate and sustained effort to improve quality, the Soviet armed forces still found it necessary to compensate for deficiencies in the tactical and technical skills of their officers and men. These compensatory measures helped frame the Red Army’s approach to war in a way that differed markedly from its Western rivals. The unique perspective that Soviet military theorists applied to historical experience also had a hand in crystallizing these differences.

Soviet ground force doctrine during the Cold War relied on the mobility of mechanized formations and combined-arms integration but, nonetheless, assigned a central role to the tank. Large groups of armored vehicles, organized into tank armies or tank or mechanized corps, were organized to attack simultaneously at multiple points along a broad front. Successive offensive operations aimed not merely at attrition but at striking rapidly throughout the depth of the enemy position. Thus, after destroying the adversary in its forward tactical zone, follow-on forces would exploit penetrations, break through and thrust deep into the rear—setting the conditions for the enemy’s encirclement and eventual annihilation.⁴⁷ In the Soviet view, war was won at the operational level, where commanders directed armies and corps moving at high rates of advance to specific points of penetration. This put a premium on centralized control, meaning that operational commanders were granted the flexibility to mass forces for the decisive blow and to reinforce success with precision and efficiency as a dynamic situation unfolded. Tactical commanders, in contrast, could not fight with the same latitude.⁴⁸ Those below regimental level were expected simply to adhere to the plan, knowing that their superiors were prepared to accept local setbacks while seeking to exploit operational breakthroughs elsewhere.

Doctrinal differences that affected the composition of military organizations and the nature of junior officer leadership also shaped Soviet tank design. An approach to war that entailed huge armored formations attacking in successive echelons at multiple points called for thousands of tanks. Furthermore, under the Soviet model, these would be manned by a mass army of conscripts. Though less sophisticated than NATO tanks, the T-54 and T-55 met the requirements of Red Army doctrine without exceeding the technical skill levels of their crews. Their simple design translated into greater mechanical reliability for an army sensitive to the

diminishing effect of distance on an attacking force. The T-54 and T-55 were ready-made for the contemplated march from the borderlands west across Central Europe to the Rhine River without refueling. The tank's running gear and powertrain were crude but rugged, introducing a slimmer chance of vehicle breakdown and affording more logistical independence to a force that depended on the overwhelming weight of numbers applied with operational (if not tactical) finesse. That being the case, simplicity in design also meant that the T-54 and T-55 could be mass-produced at low cost. As the Soviet armed forces "mass-produced" soldiers conscripted from diverse ethnic backgrounds and drawn from a population with limited technical skills, the fact that tank design simplified both training and crew maintenance was not insignificant.⁴⁹

Before examining the details of Moscow's assistance to the Egyptian military in the late 1960s and early 1970s, it is vital to keep the Soviet approach to war in mind. That approach shaped doctrine, organization and training—as well as the design of major weapon systems. It also reverberated throughout the Red Army to influence maintenance practices. By incorporating increased reliability into tank design, for example, Soviet engineers offset the technical shortcomings of vehicle crews. In a similar vein, senior commanders placed much less emphasis on quickly repairing inoperable tanks than they did on pursuing the pattern by which they attained operational success. To be fair, the same might be said of the U.S. Army. But, in the case of Soviet maintenance, the lack of emphasis corresponded to a lack of means. In short, Egypt's patron had limitations that drove it to accept certain compromises in its approach to fighting and sustaining war. These, in turn, influenced the substance of Soviet aid and advice.

Soviet military assistance to Egypt came in the form of more sophisticated weapon systems and an expanded personnel presence. Working from the shared assumption that it would take more than hardware alone to close the gap with the IDF, the Egyptians and their Soviet benefactors both sought to improve competence in Egypt's armed forces. After the Six Day War, the number of Soviet trainers, military technicians and specialists in the country rose from a few hundred to as many as 20,000, according to some accounts. The bulk of these personnel manned and guarded SAM-3 air defense installations. About two hundred Soviet fighter pilots along with their supporting ground crews helped patrol the skies over Cairo and west of the Suez Canal.⁵⁰ More significantly, an intensified advisory effort pushed beyond teaching classes on how to operate Soviet equipment and aimed for a pervasive professionalizing influence across Egyptian military formations. Some 4,000–5,000 Soviet advisors deployed to training facilities, air and naval bases and maintenance depots. They eventually provided coverage to every air force squadron and army battalion. Artillery and armor units received the most attention, with 10 advisors per battalion.⁵¹

The presence of Soviet personnel in Egyptian ground combat units proved short-lived. The advisors had reported to their assignments intent on molding units and staffs into a force that would employ its complement of Soviet equipment in the Soviet tactical and operational style. This mindset overlooked the possibility that Red Army doctrine based on combined-arms fire and maneuver, multiple penetrations across a broad front and coordinated strikes throughout the enemy's depth might be incompatible with Egyptian capabilities and strategic objectives. While some principles of Soviet military thought no doubt resonated, this fundamental misalignment in the *substance* of training threw sand into the gears of an already strained relationship.⁵² Exceptions notwithstanding, the Soviets disdained Egyptians officers and found them obstinate pupils. The Egyptians, for their part, bristled under Soviet tutelage and distrusted the advice of their typically brusque and condescending mentors.⁵³

This tension did little to abate the high-level wrangling over weapons delivery restrictions and delays to which the Soviets subjected their clients. Matters came to a head in July 1972, when Moscow rebuffed Cairo's repeated requests for offensive weapons that might—in Moscow's view—destabilize the Sinai. In response, President Anwar Sadat ejected the Soviet advisors. Thousands departed. But most of the personnel ushered out of the country had been attached to Egyptian combat units. Soviet instructors and technical specialists remained, particularly those responsible for sophisticated electronic and missile equipment. Operating and maintaining these kinds of systems demanded skills beyond what Egypt's armed forces possessed at the time. Indeed, after tensions receded and weapon shipments resumed months later, Sadat permitted many Soviet experts to return.⁵⁴

The abrupt removal of a large portion of this foreign contingent reveals much about the institutional awareness of Sadat and his senior commanders. In dismissing the advisors seeded throughout various echelons of the armed forces while allowing Soviet technical experts to stay, the Egyptians acknowledged certain strengths and weaknesses. Aligning war aims with the military means readily available, Sadat astutely shed superfluous Soviet assistance but retained what he considered essential.

Egyptian Planning: Aligning Ends and Means and Sifting Soviet Support

By 1971, Egyptian leaders had devised a plan to support Sadat's overarching goal of breaking the diplomatic logjam with Israel. From a strategic standpoint, the Egyptians only needed to cross the Suez Canal at several points and hold these bridgeheads against IDF counterattacks. Simply by clinging to this small slice of the Sinai, Egypt could vastly improve its chances of wresting a favorable postwar settlement once the superpowers intervened to put an end to the conflict (as many assumed they would). In electing to conduct such a limited campaign, Sadat and his senior commanders eschewed ambitious schemes of liberating the entire Sinai and strove for something that the army and air force could reasonably achieve. It was a decision that reflected a relatively long and clear-eyed view of the Israelis and themselves; for this, the Egyptians deserve credit.

Aside from the actual crossing, keeping the Israeli Air Force (IAF) at bay was deemed perhaps the most critical task. The plan thus called for an advance out to—but not beyond—the range of Egyptian surface-to-air missiles (SAMs) remaining west of the canal. Under this protective aerial “umbrella,” Egyptian ground troops could establish defensive positions and await the anticipated arrival of the IDF's vaunted armored forces. They would neutralize this threat with infantry equipped with great numbers of Soviet antitank guided missiles and painstakingly trained in their use.⁵⁵ So, while the plan relied on technically-capable air defense and antitank contingents, it did not require an army and air force well-practiced in Soviet-style fire and maneuver. Indeed, the Egyptians rejected key principles of this doctrine.⁵⁶

Cognizant of his operational needs, Sadat felt no obligation to retain Soviet advisors in his combat units—especially since their ubiquitous presence had not only cramped his freedom of action but had also grown rather oppressive in the eyes of his officer corps.⁵⁷ To be sure, the Egyptians had learned a fair amount from these individuals—not least a meticulous, scientific approach to war planning and preparation.⁵⁸ But all things considered, senior leaders assessed that their forces could manage without them. This was far from the case with trainers and specialists who possessed the technical know-how to operate and maintain the sophisticated weapon systems on which the entire strategy hinged.

The nuanced manner of ejecting Soviet advisors hinted at a self-awareness that surfaced elsewhere in Egyptian war preparations. A serious effort to increase the quality and frequency of pilot training followed the 1967 conflict. Still, this set of improvements came with a recognition that the strength of Egypt's air force paled in comparison with Israel's—most notably in terms of the number of qualified pilots. Though able to draw from a population of over 30 million, the Egyptian air force could only generate 30 trained fighter pilots annually. So instead of competing head-on, Egypt attempted to slash the IAF's comfortable margin of superiority by fielding state-of-the-art air defense systems. They did this with Soviet assistance.⁵⁹

In the same way, the country sought to put its ground forces in fighting trim. Sadat promoted the charismatic Saad El Shazly to chief of staff primarily to heal the rift (palpable following the 1967 rout) between the officer and enlisted ranks. Measures taken to reduce this unhelpful barrier to unit cohesion also served to make training more realistic. With decided energy, Shazly prodded and coaxed the military to embrace an offensive spirit characterized by calculated risk-taking. He targeted junior officers, seeking to instill in them a frame of mind inclined toward innovation, adaptation and independent action. His success here was mixed at best.⁶⁰ Relatively candid in his assessment of Egyptian officers and soldiers, Shazly seemed to grasp the persistent cultural need for centralized control. With his eyes on Egypt's eventual return to the Sinai, he sought to drive this single-minded focus into the lower echelons through chief of staff directives. One in particular outlined in detail the tasks that troops would perform in a canal-crossing operation and thus provided commanders with a clear (albeit inflexible) basis for especially-tailored training for crews and individuals.⁶¹ Top-down initiatives channeled into the well-established currents of Egyptian culture enhanced the prospects of battlefield success. Proposals that fought against the tide proved less beneficial.

Along with Shazly, both Sadat and Minister of War Ahmed Ismail knew that Egypt's armed forces could never be remade into a Middle Eastern version of the Red Army. Despite the significant progress made since 1967, technical skill levels in the military still fell short of those demanded for the kind of fast-paced, highly-mechanized war of maneuver envisioned by the Soviets. Even if fielding such a force were possible, it was not what the high command desired.⁶² Cultural incompatibilities remained. And, in any case, fully adopting Soviet-style formations and manning them with the requisite experts would only marginally improve Egyptian maintenance practices, because the Soviets had maintenance issues of their own.

While the Soviet Army's logistical doctrine endorsed the principle of continuous forward support and advocated repairing equipment as close as possible to the front, its personnel and unit organization rendered these ideals practically unachievable. Maintenance expertise resided in a limited number of specialists at regiment and division level. The tank or infantry company contained no mechanics, and the handful in each battalion could conduct little more than basic preventive maintenance. Furthermore, the absence of any recovery vehicles at lower echelons worked against the idea of responsive support.⁶³ In the Middle Eastern wars of the early 1970s, the Soviets could perhaps dismiss Arab maintenance failures as an improper implementation of sound doctrine, but the proverbial birds hatched and came home to roost years later in Afghanistan, where the Red Army itself suffered similar problems.⁶⁴ To the Egyptians' credit, they were observant enough to note imperfections in their benefactor's maintenance practices and equipment. They viewed Soviet tanks as far from optimized for desert use and looked with alarm on the relatively high crash rate of Soviet-made aircraft over Egypt in 1971 and 1972.⁶⁵ Burdened with their own intractable shortcomings, the Soviets were not really in a position to solve the

glaring maintenance issues facing Sadat's army and air force. Then again, they had already incorporated these shortcomings into an overall approach to war and did so in a way that would soften the negative impact. It was up to the Egyptians to take a similar tack.

Egyptian Planning: The Seeds of Compensation

For all their cumulative goodness, Soviet assistance and internally driven training and educational reform proved unable to transform Egyptian maintenance along conventional lines. These hopeful means of progress—though not insignificant—failed to overcome steep barriers rooted in military culture. In such cases, removing deficiencies through straightforward improvement was not enough. Nonetheless, with impressive self-awareness, Sadat and his senior commanders acknowledged the strengths and weaknesses of their armed forces and then shrewdly sought to compensate for particular weaknesses deemed too difficult to eliminate. In the early 1970s, the Egyptian high command aligned military capabilities with strategic intentions in the imminent Sinai campaign to avoid known weaknesses. This explicit plan to compensate applied also to maintenance, an area in which Egypt's military attempted to render its most detrimental shortcomings irrelevant.

At the strategic and operational levels, Sadat's restrictive war aims skirted the issue of Egyptian ineptitude in offensive combined-arms maneuver warfare. It has already been mentioned that the president's primary goal was to tarnish the sheen of Israeli invincibility just enough to jumpstart negotiations that would result in the eventual return of the Sinai. So, rather than attempt to overrun the peninsula in a juggernaut of armor, Sadat opted for an operation that called for crossing the canal, seizing bridgeheads and then defeating IDF efforts to dislodge them.

Senior commanders carefully aligned operational method with strategic aim and added flesh to the bones of this framework by drilling the entire army on the tasks required to execute a crossing and sustain a limited advance. Egyptians may have dismissed the Soviet style of warfare as incompatible with their goals and capabilities, but they took the Soviet penchant for detailed planning to astounding extremes. Based on this kernel of Red Army doctrine, staff officers developed a plan so tightly-scripted that it rendered the need for improvisation obsolete at the small-unit level. This was, of course, by design. Egyptian junior leaders lacked the tactical savvy to improvise in the first place, and their superiors acknowledged as much. A meticulously-written and well-practiced plan sought to compensate for this weakness.⁶⁶

And practice they did. In the years immediately preceding the 1973 campaign, units rehearsed constantly. Squads and platoons trained on mockups of Bar-Lev Line fortifications. "Tank-hunting teams" of infantry familiarized themselves with Sagger wire-guided antitank missiles repeatedly over the course of several months, firing up to 25 per day on special ranges. The dissemination of explicit, detailed instructions enabled soldiers across the armed forces to hone the specific skills that would be required of them during the anticipated assault.⁶⁷ Israeli commentator Chaim Herzog describes this display of energy and grit in *The War of Atonement*:

Each unit dealt with its own problem and nothing else. One unit did nothing for three years but train in passing across a water barrier a pipe for transporting fuel; while every single day for three years bridging units would train in backing up trucks to a water barrier, stopping abruptly at the water edge, causing the elements of the PMP heavy folding-pontoon bridge on the truck to slide by momentum into the water, before they

bolted together the two elements of the bridge and drove off. Twice a day during four years these units assembled and dismantled the bridge. Similarly, every day for years all operators of Sagger antitank missiles lined up outside vans containing simulators and went through half an hour's exercise in tracking enemy tanks with their missile.⁶⁸

The same was true for every individual soldier—memorizing directions and repeatedly running through the exact steps that would take them across the canal and help them defend their gains.

Compensating for Tactical Weaknesses: Sagger and SAMs

To achieve Sadat's principal war aim—however limited—the armed forces still had to win battlefield engagements against the IDF. Here again, through planning and adaptation, they compensated for known weaknesses at the tactical level just as they had done at the strategic and operational levels. In spite of the measures taken since the 1967 defeat, junior officers in the Egyptian army still lacked the initiative required to respond to the rapid unfolding of events that occurred in mobile warfare. Little could be done to alter the force's cultural predisposition in five years. In fact, the almost fanatic emphasis on training and rehearsals did more to reinforce rigid adherence to the plan than to encourage a collective spirit of innovation and creativity. So, instead of cutting against the grain, the senior command capitalized on its soldiers' demonstrated competence in defending from fixed positions.⁶⁹

Given this tactical approach, staff officers formed the initial assault waves around a solid core of infantry. They also considered crossing the canal quickly on a wide front to be essential for maximizing surprise. Thus, the practical matters of physics and time further encouraged planners to rely on mobile light infantry and commandos to execute the critical opening moves of the land campaign. Bridges required for the passage of armor and heavy equipment took longer to construct and emplace.⁷⁰ On 6 October, five infantry divisions breached the Bar-Lev Line and pressed on to establish bridgeheads up and down the western shore of the Sinai at a depth of only a few miles. As planned, they stopped well within the protective umbrella provided by SAM batteries remaining on the Egyptian side of the Suez Canal. Although an armored brigade reinforced each division, the burden of repulsing the IDF's anticipated counterattack fell to infantry equipped with antitank guided weapons.⁷¹ In previous months, the high command had redistributed these weapons, stripping them from reserve units and follow-on forces in order to bolster the strength of lead elements whose success was strategically vital.⁷²

Tactics associated with a limited advance, coupled with digging in and bracing for a counterblow, suited the Egyptians for another reason. By compelling the IDF to attack fixed positions, they exploited their adversary's cultural sensitivity to casualties.⁷³ While the crossing itself surprised the Israelis, Sagger- and RPG-armed infantrymen compounded the overall shock by inflicting serious losses. Furthermore, they delivered a psychological blow to an armored force that was unaccustomed to being knocked back on its heels. Rushing to relieve besieged forward fortifications, the Israeli tank division stationed in the Sinai charged into established killing zones and saw its strength gutted in a matter of hours. By noon on the second day of the war, the three brigades of this division had lost nearly two-thirds of their armor. One of them reported 23 tanks operational, another only 10.⁷⁴ A reserve division deployed to the front launched a counterattack on 8 October and met a similar fate.⁷⁵ One commentator estimated that in the first three days of the Sinai campaign the Israelis had 400 tanks put out of action.⁷⁶

Thrusting forward into prepared defenses bristling with antitank weapons, Israeli armored formations—unaccompanied by infantry and without air or artillery support—played right into the hands of their enemy.⁷⁷ In a triumphal diary entry, Sadat's armed forces chief of staff critiqued with disbelief his foe's tactical blunders:

The enemy has persisted in throwing away the lives of their tank crews. They have assaulted in "penny packet" groupings and their sole tactic remains the cavalry charge. . . . In the past two days the enemy has lost another 260 tanks. Our strategy always has been to force the enemy to fight on our terms; but we never expected them to cooperate.⁷⁸

Despite their studied prewar assessments, even the Egyptians were amazed at the IDF's recklessness in the immediate aftermath of the crossing.

In the same way, the Egyptian air force reaped success during the opening days of the war due to adaptation stemming from a keen awareness of themselves and their adversary. Arab airpower had been destroyed in the first hours of the Six Day War. Despite heroic efforts since then to procure new planes, to train pilots and to rebuild facilities, the Egyptians remained inferior to the Israelis when it came to controlling the air.⁷⁹ They acknowledged as much and tailored the air force's approach in order to deal with their adversary's well-established qualitative advantages. Identifying the discrepancy in airpower as a "fundamental weakness," the military's chief of staff ordered his pilots to avoid air-to-air engagements and "chance encounters" with the IAF and to limit their operations to hit-and-run raids on targets in the Sinai.⁸⁰

Egyptian humility seemed to encourage Israeli hubris. Disdainful of Arab society and its apparent backwardness, the Israelis dismissed as remote the possibility of war in 1973 largely due to assumptions related to their opponent's military readiness. Sadat's dismissal of Soviet advisors in 1972, for example, was assessed to have set war preparations back by about three years. This vanishing technical expertise constituted something of a concern for the Egyptians, but it all but blinded the Israelis. They could not see how a military could initiate hostilities ostensibly without the means to operate a sophisticated air defense system.⁸¹ This, along with the dreadful state of the adversary's air force, made conflict far from imminent in Israeli eyes. Yet the kind of tactics the Egyptians sought to employ did not require the kind of force the Israelis had come to view as essential for modern war. Alternative tactics that minimized its weaknesses enabled the Egyptian military to reach for Sadat's objectives while sidestepping the IAF's anticipated counterpunch.

IAF combat losses in the first days of the Sinai campaign seem to vindicate the Egyptian approach while highlighting the consequences of Israeli myopia. On 6 October, 250 Egyptian planes struck targets across the depth of the peninsula. Though causing some casualties and physical damage, this attack was generally ineffective. Rising to defend their country's airspace, Israeli pilots downed 18 of their enemy counterparts; in doing so, they dissuaded the Egyptian high command from launching a second wave of sorties. Egyptian aircraft retired to hangar facilities following these initial strikes and, for the most part, remained there.⁸² The lopsided air-to-air engagements only confirmed the wisdom of Shazly's instructions to leave the IAF to Egypt's air defenses positioned along the canal.

When the fight shifted to turning back the ground attack, the IAF began to see its numbers decline. Four planes were shot down in a matter of hours as they flew into the protective "bubble" formed by Egypt's dense network of missile and gun batteries. Awakening to the danger of mobile SAM-6 launchers, pilots reduced altitude—only to come within range of

antiaircraft artillery fire. This unanticipated combination of threats diminished bombing accuracy by not only distracting embattled pilots but also by prompting them to release their payloads at farther—and thus safer—distances.⁸³ Losses accumulated rapidly. Two days into the war, the quantity of destroyed aircraft reached 44, spurring the IAF's top commander to prohibit missions within 15 miles of the Suez Canal. All told, 109 planes were lost in operations against the Arabs—over two-thirds of them due to ground fire.⁸⁴

Egypt devised an operational and tactical plan to achieve Sadat's strategic aims so as to minimize the effects of its military weaknesses, particularly a junior officer corps ill-suited for the challenges associated with offensive maneuver warfare. The limited advance leading to a set-piece battle in which Egyptian soldiers defended from fixed positions was highly-scripted and rehearsed, making improvisation and independent judgment practically unnecessary for small-unit leaders in the opening moves of the campaign. Furthermore, the shrewd employment of antitank weapons and robust air defenses more than offset IDF superiority at the tactical level.

Egyptian Logistical Support: Bridges and Bullets

The practice of intentionally compensating for weaknesses while leveraging traditional competencies was evident in Egyptian logistical support as well. In Sadat's plan to open negotiations from a position of relative strength, nothing surpassed the crossing in terms of importance. Sizable ground forces had to establish themselves on the far side of the Suez Canal, withstand the inevitable counterattack and remain a viable military threat until the imposition of a ceasefire.

The Egyptian military's 15,000-strong corps of engineers played perhaps the preeminent role in enabling these tasks. In the months preceding the assault, the corps had constructed over 12,000 miles of roads to support the rapid movement of troops and supplies to numerous embarkation sites on the west bank of the canal. As for the opposite shore, engineers had devised a way to make short work of the Bar-Lev Line's steep berm: special pumps positioned along the canal shot high-velocity streams of water that pounded the sand barrier, creating around 80 vehicle-wide lanes. This idea bubbled up from the ranks of the engineer corps over two years prior to the crossing and had been put to the test in hundreds of experiments.

These examples of diligence and creativity facilitated mobility on either side of the canal and helped to make the crossing a reality. By the end of the first day, combat engineer battalions had emplaced eight heavy and four light bridges and eventually assembled some 20 bridges distributed throughout the sectors of the five attacking divisions (in addition to roughly 50 tank ferry sites).⁸⁵ The challenges of emplacing bridges across the 200-yard canal in multiple sites were not insignificant either. The Egyptians met the dangers of tidal changes and rapid currents remarkably well.⁸⁶

What is more, Egyptians maintained these bridges in the face of Israeli air strikes. The IAF initially targeted pontoon bridges as a way of disrupting the crossing, but they soon found that Egyptian engineers repaired the damage so quickly as to render bombing and strafing runs nearly fruitless. In their military inventory, the Egyptians had a conglomeration of British and Soviet bridging equipment. What made the spans across the canal relatively easy to restore was their sectional construction. Trained extensively on bridge emplacement, Egyptian engineers had also prepared fastidiously for the task of changing out damaged sections. They had even

modified sections to make them interchangeable across various bridge models. Lashed inconspicuously to the banks during daylight hours, spare sections could be ferried to the point of need fairly quickly.⁸⁷ The competence of Egyptian engineers accounted for cycles of misplaced cheer, confounded surprise and frustration at Israeli headquarters in the war's early days. Chief of the Israeli General Staff, David Elazar, recounted one such instance: "We destroyed seven of their bridges, and everyone was happy. The next day the bridges were functional again. [The IAF] destroyed every bridge twice . . . one of the bridge's sections is destroyed, and after an hour another piece is brought in and the bridge continues to function."⁸⁸

Bridge-laying and repair work complemented the Egyptian military's traditional strength of providing logistical support under challenging conditions. Despite lavish ammunition expenditures, Egyptian formations in the Sinai never wanted for any class of supply. The water situation was admittedly tenuous until pipes were laid across the canal three days into the campaign.⁸⁹ Otherwise, army units received all they needed to sustain themselves until just prior to the ceasefire, when IDF armored columns surged into Africa and threatened the Egyptians in the Sinai with encirclement. The performance of the quartermaster corps provoked few complaints from Egyptian commanders and even drew grudging praise from Israeli observers.⁹⁰

However, 1973 was not the first instance in which the Egyptian military displayed the institutional skill of moving and supplying its forces under demanding conditions. Although the Six Day War terminated before the logistical system could be tested, the military had sustained a 70,000-man expeditionary force some 2,000 miles away in Yemen from 1962 to 1967. This attempt to crush a royalist insurgency and thus bolster pan-Arabism on the Arabian Peninsula ended ingloriously for Egypt, but the failure stemmed from tactical rather than logistical reasons. Egyptian ability to plan and execute sustainment operations for large formations over long distances elicits applause from analysts.⁹¹ In the case of the Sinai campaign, excellent logistical support and the engineers' almost flawless facilitation of movement across the canal seem less surprising in light of similar success in Yemen years earlier.

Egyptian Logistical Support and Maintenance: The Performance Gap

How does the competence demonstrated by engineers and quartermasters square with the lackluster maintenance record of the Egyptian armed forces during the war? While these sets of skills all fall under the category of combat support, they are in fact distinct. Proficiency in one area does not necessarily transfer to another. Still, given Egyptian engineers' expertise in repairing damaged bridges, one might reasonably expect to observe a vaguely comparable manner of performance when it came to repairing armored vehicles.

The performance gap between the two may be explained in part by differences in perceived criticality. To be sure, Egypt's return to the Sinai consisted of several critical tasks, but none was more instrumental in achieving Sadat's war aims than crossing the canal quickly and in substantial force. After seizing multiple bridgeheads on the eastern bank, the Egyptians established positions under the protective umbrella of their air defenses and parried IDF counterattacks with infantrymen toting antitank guided missiles. Sadat anticipated a short conflict, ended by way of a ceasefire brokered by the superpowers. If he could reach that point with his troops still ensconced on the far side of the canal, then Sadat could claim victory and, in the process, shatter the IDF's sense of invulnerability—a prerequisite for forging a favorable long-term settlement. In some sense, Egypt's entire concept for the Sinai campaign made the issue of tank repair immaterial. As long as his forces could get across and offer a solid defense for

a limited time, Sadat could accept abysmal maintenance during combat operations. What is more, the plan itself sought to compensate for this known weakness.

Although maintaining vehicles and equipment over the course of a campaign could be viewed in this case as a task of relatively minor importance, physically crossing the canal could not. It required bridges and well-trained engineers to emplace them. A serious shortage of either of these would render the operation infeasible; such shortcomings—if they persisted—could not have been sidestepped by compensating elsewhere. Recognizing the engineer corps' irreplaceable role in any future endeavor to recapture the Sinai, the Egyptian high command bolstered its capability through recruitment and the organization of nearly 40 combat engineer battalions in the space of two years.⁹² Each was raised with a specialized mission in mind, whether operating small boats across the Suez Canal or building bridges. One, for example, served as a “dummy bridge battalion” that erected light bridges as decoys to muddle IAF targeting.⁹³ General Shazly called the formation of these distinctive engineer units “a top priority” and “our biggest coup and the foundation of our success.”⁹⁴

Despite the inherent difficulty of crossing a defended water barrier, the meticulous planning and centralized control it demanded suited Egyptian military culture. The approach of staff officers to this complicated military problem was deliberate to a fault. According to Shazly, “we had a straightforward technique. We tackled each aspect in turn, breaking it down into even smaller components until, piece by piece, we could construct a solution.”⁹⁵ This, of course, was the tack taken for the whole campaign. But the penchant for rigid centralization so evident in Egyptian military culture found particularly acute expression in the crossing operation.⁹⁶ Along with the matters of priority and relative criticality mentioned above, the alignment between military culture and the nature of the engineers' principal mission help to explain why the conduct of the crossing drew praise while the broader maintenance effort was roundly disparaged.

Even though the high command distributed combat engineer units up and down the length of the canal, the responsibility for negotiating this imposing water obstacle fell mainly on the shoulders of the chief of engineers. Shazly assigned the engineers six key tasks, from bridge-building and berm-busting to rubber-boat assault and ferry construction, and then followed their preparations closely.⁹⁷ Teams trained repeatedly on a set of discrete and predictable subtasks. Occurring at the opening of the campaign, the crossing operation was well-shielded from the accumulating friction that habitually derailed even the most prescient timetable. Specialized battalions thoroughly rehearsed in specific tasks were assigned to specific, predetermined and often fixed sites along the canal. Subjected to this centralized arrangement, the variables affecting the crossing were minimized and thus more easily managed.

By way of comparison, conducting vehicle maintenance on the far shore presented a distinct—and arguably more difficult—challenge. Once over the canal, armored and infantry units pushed a few miles inland and established defensive positions. As they spread out across a wide front, their movements naturally made the repair and recovery system supporting them less responsive. The task of fixing inoperable or damaged vehicles relied on a geographically dispersed collection of unevenly proficient crews, mechanics and depot personnel. In contrast, the technical expertise resident in engineer battalions was concentrated at a limited number of crossing sites. Moreover, swapping out a destroyed section of pontoon bridge near the canal posed less of a mechanical problem than overhauling or replacing a tank engine miles from the nearest repair facility.

Again, engineering excellence did not necessarily translate into responsive maintenance support. The conditions framing the pursuit of each differed markedly in the case of the 1973 Egyptian army. Characterized by a centralized approach and driven by detailed top-down planning, the former fit well with the customary drift of Egypt's military culture. The latter cut against that familiar grain and defied aspirations of mastery for an army ill-equipped for the decentralized application of sophisticated technical skill.

Self-Awareness and Internal Consistency: Keys to Compensation

Rather than focus on correcting this shortfall in maintenance capability, the Egyptians sought to compensate for it. The high command's strategic and operational plans, as well as its prescribed tactics for subordinate units, worked indirectly to minimize the importance of sustaining offensive combined-arms maneuver over a prolonged campaign. Senior leaders enacted more direct measures as well. To offset their weakness in vehicle recovery and repair, the Egyptians established forward-supply depots geared toward replacing end items and continued to accept Soviet arms shipments.⁹⁸ They also sidestepped an otherwise unavoidable logistical management issue by following the Soviet doctrinal practice of replacing *whole units*. Instead of scrambling to maintain engaged units at full strength through the repair of individual weapon systems, the Egyptians purposely kept those units in the fight and allowed their combat effectiveness to dwindle via attrition.⁹⁹

Sadat and his military advisors acknowledged their armed forces' maintenance deficiencies internally, but they also broadcasted selected ones to their adversary. Indeed, the high command exploited Israel's skewed perception of the balance of power in the Sinai by seeking to mislead the IDF about Egypt's readiness to go to war. Since 1968, the Egyptian army had periodically conducted large-scale exercises in the vicinity of the canal. Intended to depict the staging of an imminent crossing, these exercises served to lull the IDF into a false sense of security such that, when the hammer of the real attack fell, the Israelis would be caught flat-footed. The frequency of maneuvers increased throughout 1973, occurring 22 times.¹⁰⁰ During these later episodes, the Egyptians accentuated the numbing effect on Israeli preparedness by leaking information about the sad state of Egyptian equipment. Reports conveyed an unmasked sense of disappointment in the reliability of Soviet hardware. Adding to these complaints, soldiers openly voiced concerns about acute shortages of spare parts and the low maintenance level of air defense systems.¹⁰¹

In advertising these deficiencies—not all of them imagined—the Egyptians tapped into an influential vein of Israeli overconfidence and reinforced their adversary's preconceived notions of Arab technical backwardness. Such views held that the Egyptians were not sophisticated enough to plan for—let alone execute—a crossing of the canal in force.¹⁰² Transmitting calculated messages on operational readiness only helped to confirm the belief that an attack was far from likely (or even feasible). The Israelis had allowed their knowledge of Egypt's woeful maintenance posture to be manipulated and applied to their disadvantage. In this case, Egyptian *self-awareness* stole a proverbial march on Israeli awareness regarding the same shortfall.

So long as Sadat and his senior commanders maintained a carefully-crafted consistency in Egypt's military system and sought to fight a short war for limited objectives, its maintenance deficiencies had minimal effect. The alignment of strategic aims, operational approach and tactical methods helped to compensate for longstanding shortcomings in the Egyptian army, principally the inability of junior officers to conduct offensive combined-arms maneuver. At the

same time, the alignment drew upon traditional strengths, such as defending from fixed positions and providing logistical support for deployed forces. Recognition of the military's poor maintenance practices factored into the equation as well.

The Egyptians, by design, did not rely on their maintenance capability for success in war. When casualties and equipment losses accumulated, commanders—in Soviet style—sought to replace whole units rather than prioritize the repair of damaged vehicles. The dearth of recovery assets among the Egyptian army's lower echelons only reinforced this doctrinal practice, as did the arrival of 300 additional tanks rushed to Egypt from the Soviet Union during the war.¹⁰³ Indeed, the tank design itself was far from optimal when it came to field repairs. And, in any case, Soviet tanks were built with a view toward making them less susceptible to breakdowns, in part because Soviet crews lacked the technical skills to repair them.¹⁰⁴ The Egyptian military's approach to maintenance differed markedly from its opponent for good reason, not unlike its approach to the entire 1973 campaign.

Egyptian Overreach and the Unraveling of Internal Consistency

The effects of poor maintenance grew more disruptive for Egypt, however, as the conflict dragged on and the careful correlation of ends, ways and means became strained and unbalanced. While fighting in the Sinai had settled into something of an "operational pause," Syria's position on the Golan Heights had deteriorated. By 9 October, Sadat's embattled ally to the north faced an impending counterattack that would eventually culminate with an IDF breakthrough onto the Damascus plain. Under political pressure to relieve Syria, Sadat ordered his commanders to attack out of their bridgeheads toward the Sinai passes some 20 miles distant. Consisting of about 1,000 tanks—including most of the Egyptian armored reserve—the assault commenced the morning of 14 October and was driven back with great loss. For one thing, Israeli formations had recovered from the shock of the campaign's opening phases. Rested and somewhat reconstituted, they also enjoyed the advantage now of defending familiar terrain with the help of sophisticated wire-guided antitank missiles rushed from the United States. The IAF too could bring its devastating firepower to bear more freely on Egyptian armored columns once those elements had advanced outside the range of their protective air defense umbrella.¹⁰⁵

Still, this disastrous lurch forward only confirmed what had been growing more obvious: the impressive combat performance displayed during the actual crossing and so evident in blunting Israel's initial counterattacks could not be sustained. In preparation for the campaign, pertinent individual skills had been trained with exacting specificity; small-unit battle drills had been relentlessly rehearsed; and combined-arms tactics—ordinarily beyond the capability of Egypt's junior officer corps—had been written into the detailed script of the operation. The results, as described, were incredible, not least from the Israeli perspective. But when the script ran its course, the traditional shortcomings reappeared.¹⁰⁶

In the attack of 14 October, the Egyptian army overreached and never recovered. By the end of the day, its forces had retreated to their bridgeheads. All told, they lost 250 tanks in the attack—a number exceeding the 240 that had been destroyed in the first *week* of combat. Signaling the turning of the tide, Egypt's failure on the 14th paved the way for an IDF thrust that ultimately resulted in three Israeli divisions crossing the canal into Africa before the war's end.¹⁰⁷ Both sides would continue to engage in extremely tough fighting until that time. As the days passed, however, the Egyptian military's woeful maintenance practices meant that its commanders and crews operated at an ever-widening disadvantage vis-à-vis their Israeli counterparts.

Israeli Maintenance Mindset: Compensating for Quantitative Disadvantage

In contrast, maintenance occupied a more prominent position in the IDF's military system because it went far toward offsetting the quantitative superiority of Arab forces. Based strictly on numbers, the differences in total strength were plainly evident. The available army manpower in the IDF stood at 310,000—substantially less than the estimated 505,000 ground troops that Arab states committed to the conflict. A similar comparison of tanks favored Israel's opponents by a margin of two to one.¹⁰⁸ On either side of the canal on the day that the war began, the difference was even more stark. Some 200,000 Egyptians of the Second and Third Armies had concentrated against a division-sized combat force of 18,000 Israelis assigned to defend the Sinai. In three to five days, the IDF could partially close the gap by mobilizing additional brigades totaling another 100,000 men.¹⁰⁹ Yet the anticipated requirement of urgently marshaling reinforcements only underscored the quantitative disadvantage under which Israel labored, even with the modest benefit of central position. Thus, the superior *quality* of its armed forces served as a cornerstone of the country's defense—and maintenance was a part of this overall equation.

Given its limited strategic depth, Israel relied on a seasoned intelligence apparatus to provide advanced warning and on a well-honed mobilization system to respond rapidly during contingencies. Failures and disruptions in both areas at the beginning of the October War drew serious criticism. Not all equipment proved combat-ready when the time of crisis came, and glaring maintenance issues emerged. Nearly half of the IDF's reserve tanks experienced some form of maintenance fault that required corrective action, while the active component suffered from similar shortcomings. Almost 100 reserve tanks were reallocated after many of the crews in frontline units discovered that the tanks awaiting them in depots had maintenance problems.¹¹⁰ In a battalion assigned to Major General Ariel Sharon's 143rd Armored Division, none of the half-tracks would start. Equipment shortages further marred an already condemnable state of affairs: one of Sharon's tank battalions had to deploy without mortars while another lacked turret-mounted machine guns.¹¹¹

Such disconcerting indicators of unpreparedness and confusion prompted a post-conflict overhaul of the IDF's depot system. Following the war, the Israelis positioned weapons, ammunition and armored vehicles in forward depots near the Sinai passes and specifically assigned personnel there to conduct routine engine starts, lubrication and other preventive maintenance tasks. Doing so avoided the prospect of undertaking a massive long-distance transport operation in the early days of the next military contingency.¹¹² Israel had always recognized the importance of mobilizing quickly and effectively in order to compensate for its tenuous geopolitical situation as a small country surrounded by enemies. In paying closer attention to peacetime maintenance after 1973, Israel more closely aligned its posture with that goal.

Nonetheless, after recovering from the surprises of the campaign's opening phases, the IDF turned in a performance that—at least in terms of maintenance—demonstrated its ability to fight as it had intended. In the Israeli way of war, skilled tactical leaders and technically-proficient weapon crews were top commodities. The challenges of maneuver warfare were best handled by officers and men accustomed to exercising initiative in the midst of fast-paced, decentralized operations. What is more, against a numerically superior foe, these qualities applied also to the realm of maintenance in the sense that every armored vehicle counted. Expert crews and mechanics supported by a responsive maintenance system designed to recover and repair

damaged vehicles quickly could make them *count*—in a manner of speaking—more than once. This is precisely what happened in the Israeli case.

In their analysis of the 1973 war, Cordesman and Wagner highlighted the significance of “repaired tanks” in the overall calculus of Israeli combat strength. The IDF’s “ability to repair damaged tanks and return them to combat played an important role in keeping the Israeli military functioning at a high level of proficiency.” According to Cordesman and Wagner, it helped the Israelis to “turn the tables on the Arabs.”¹¹³ Vehicle crews generally possessed both the know-how and the tools to make on-the-spot repairs and did so whenever possible.¹¹⁴ Of course, not all combat vehicles could be fixed at the front. Damage sustained might exceed repair capabilities on hand. Likewise, the tactical situation, with its frontline ebb and flow, prohibited extensive on-site repairs at times.

Notably though, the IDF recovered vehicles and moved them to more maintenance-conducive locations even when the process proved far from inviting. Division commander Bren Adan mentioned the recovery of two tanks damaged in an ambush while attempting to relieve an IDF strongpoint early in the war.¹¹⁵ Days later, on 9 October, Adan’s troops repulsed an Egyptian probing attack. During the hectic night that followed, units in his sector established a thin outpost line while the balance of the division pulled back a short distance to bivouac sites. As vehicle crews set about the routine task of restocking fuel and ammunition, several took the opportunity to attend to disabled vehicles. Adan heard “the sound of hammering” echoing in the darkness and knew his crews and mechanics were hard at work.¹¹⁶

This organizational ability to repair damaged tanks at lower echelons was complemented and energized by a certain way of thinking. In the aftermath of the series of engagements across the southern front that day, Adan took stock of the situation: “Eighty tanks were hit . . . [with] fifteen of them in my division, but those remained in our territory and would be repaired. [Ariel] Sharon’s division lost about fifty tanks, eighteen of which were left behind in enemy-held territory.”¹¹⁷ This summary of tank losses draws attention to an important connection between vehicle recovery and the control of terrain, but it also illuminates a mindset that naturally viewed damaged tanks as *soon-to-be-repaired tanks*, rather than the irredeemable flotsam of battle. The fact that IDF commanders thought in these terms gave purpose and direction to the maintenance-related technical and tactical skill their crews possessed.

It helped too that the damage caused by Egyptian antiarmor weapons did not—as Cordesman and Wagner found—“permanently kill the tank.” The shaped charges of the Sagger missile and RPG-7s (rocket-propelled grenades) penetrated armor and inflicted grievous harm to the crews inside but often only disabled the vehicle itself. Once recovered, many tanks could be repaired in a few days.¹¹⁸ Adan’s division, for example, resorted to evacuating the dead and wounded, consolidating surviving crewmembers at collection points, forming new crews and then reassigning them to recently repaired tanks.¹¹⁹ Again, Israeli skill related to the task of vehicle recovery and repair proved crucial. Without this “key factor,” Cordesman and Wagner contend, the IDF would not have been able to sustain the crossing of the canal in the war’s final phase.¹²⁰ Tank strength levels would have been too low—even after accounting for the additional U.S. tanks delivered during the crisis.

Historian Trevor N. Dupuy’s estimated data on tank and air losses illustrate how the quality of Israeli military maintenance helped to neutralize the Arabs’ numerical advantage. Analyzing reports from both the Sinai and Golan fronts, Dupuy tabulates the number of tanks “destroyed

or put out of action for one or more days” and determines that the Israelis lost 840. The corresponding figure for Arab forces is 2,554. Of the 840 damaged Israeli tanks, however, nearly half were fixed and recommitted. Dupuy does not offer similar data for the Arabs. Instead, he cites another statistic that reflects well on the IDF’s maintenance capability: the Israelis also recovered about 300 repairable Arab tanks. As for aircraft, Dupuy lists Israeli and Arab losses as 109 and 447 respectively. Elaborating further, he categorizes an additional 236 Israeli warplanes as “damaged.” Of these, 215 were repaired in one week’s time. This rate of repair seems especially impressive given the analogous Arab figures: 125 aircraft were damaged during the October War, but, in the column listing the number of planes repaired in one week, Dupuy simply inserts a question mark.¹²¹ The implication—that the Egyptians repaired few, if any, damaged aircraft during the war—seems consistent with the lackluster readiness rates that their air force reported.¹²²

Thus, both the Egyptians and Israelis compensated for known weaknesses, and, in each case, relative maintenance capability informed these calculations. Egypt sought to minimize the impact of its military’s maintenance shortcomings through a carefully-tailored operational approach to a limited campaign. The IDF, for its part, offset its numerical disadvantages and lack of strategic geographical depth by capitalizing on qualitative strengths, like maintenance excellence. The relationship between maintenance proficiency and deliberate compensation involved factors established well before the start of the 1973 conflict. That is to say, little could be done to alter existent personnel skills, training priorities and planning assumptions once Egypt began its assault on the Bar-Lev Line.

Of course, both sides benefited from airlifts that delivered tons of military hardware over the course of the war, but these efforts—substantial though they were—did not alter how each side viewed maintenance and its influence on planned operations, particularly in Israel’s case. Eager to serve as key mediators of the conflict and to improve the U.S. relationship with Arab states while eroding Soviet sway in the Middle East, American leaders initially had withheld material support for the Israelis, whom they expected to win handily regardless. However, given dramatic IDF setbacks in the war’s opening stages, commencement of the Soviet airlift to Egypt and Syria on 9 October and Israel’s persistent pleading, President Richard M. Nixon decided to provide emergency military assistance to the Jewish state. The U.S. airlift, dubbed Operation Nickel Grass, began on 14 October and continued through the 28 October ceasefire until mid-November.¹²³ It eventually delivered about 75 fighter planes, 175 tanks, 250 armored personnel carriers and 50 artillery pieces, as well as critical munitions like state-of-the-art wire-guided antitank missiles.¹²⁴ Nixon’s delay in launching the airlift meant that the equipment arrived *after* Israel’s successful counterattack on the northern front of the Golan Heights and its defeat of Egypt’s attempt to expand the Suez Canal bridgeheads. Thus, Nickel Grass did not necessarily save Israel from destruction, but it did provide an enormous psychological boost while communicating U.S. political commitment to an otherwise besieged regional partner. Most significantly, the assured delivery of additional aircraft, armored vehicles, spare parts and ammunition offset the risks associated with the eventual IDF counterattack west across the canal, especially since Egypt continued to apply pressure at various places along the Sinai front.¹²⁵ Still, despite these positive impacts on Israeli decisionmaking and military operations, the U.S. airlift does not negate the role that IDF recovery and repair played at the immediate point of need. Such maintenance practices remain factors that compensated for quantitative disadvantage, particularly during the first week of the war.

The Role of Technical Familiarity in Prewar Adaptation

There appears to be a faint connection between maintenance capability and the technical mastery of one's equipment. Poor maintenance performance serves as an indicator of limited technical skill among crews and operators. Along these lines, it could help explain why some military organizations fail to take full advantage of their weapon systems, especially sophisticated ones. The Egyptians, for example, had trouble exploiting the tank's inherent mobility. Shortcomings in the tactical leadership of junior officers—rather than shoddy repair practices—bear most of the blame for this constraint.¹²⁶ And, in any case, the high command that devised the 1973 Sinai campaign was not inclined to emphasize armored vehicle mobility as a top concern. In the plan, tanks served instead as indisputable tokens of Egyptian strength to be lodged on the east bank of the canal and, secondarily, as a backstop to infantry formations defending the bridgeheads. Nonetheless, the dismissive attitude toward mobility morphed into a pronounced vulnerability when the Syrians pressured Sadat to resume the offensive and press on to the Sinai passes. This vulnerability grew more acute as the war progressed, and Egypt suffered tank losses it could not redeem.

Poor maintenance in the Egyptian armed forces did not, of its own accord, prevent crews from using their tanks effectively. Still, systemic maintenance problems point to a certain level of persistent technical clumsiness. This makes a difference in combined-arms warfare, where commanders often must leverage the mobility of their combat vehicles in order to win tactical engagements. As one scholar explains, leaders who lack sufficient technical know-how function at a marked disadvantage:

A tank officer who does not feel in perfect command of his tank and feels insecure about even a small portion of his weapon will be unable to meet the rapidly changing conditions of actual combat. An army that feels it possesses the complete ability to maintain, design and adapt its weapons has a new sense of self-confidence. . . . The rapid and competent repair of weapons, the *clever and original* adaptation of devices, the close relationship between the engineer, the officer, and the soldier all lead to this desired effect.¹²⁷

The connection between poor maintenance, substandard technical skill and failing to employ weapon systems in a way that maximizes their potential becomes more distilled given the relative quality of tanks each belligerent used in the 1973 war. The Centurions and M-60s in the IDF's arsenal were comparable to the T-62s that had been fielded in some Egyptian units. True, Egypt's armored brigades consisted largely of older T-54s and T-55s.¹²⁸ But, as Cordesman and Wagner relate, even Israeli tank commanders assessed that "both Western and Soviet tanks had a balanced set of strengths and weaknesses," with the latter judged to be more reliable.¹²⁹ Generally speaking, the quality of the crew, technical familiarity with the weapon system and the practiced skill of employing it mattered more in battle than the specifications of the platform itself.¹³⁰

The functioning of the Egyptian military's air defense system during the war provides another example of how technical familiarity affected operational employment. Guarding the skies over the canal was a dense network of antiaircraft gun and missile batteries consisting of Soviet systems that varied in terms of capability. Old standbys like the SAM-2 and SAM-3 had operated along the canal for several years. Arduous to dismantle and slow to move and recalibrate, these systems also carried another disadvantage: Israeli pilots knew both models well, and their aircraft had been equipped with electronic countermeasures that rendered the missiles

basically ineffective. The SAM-6 and SAM-7, however, recent additions to the Egyptian air defense arsenal, proved more of a challenge. Highly-mobile and fitted with advanced frequency-hopping technology, these weapon systems could circumvent existent IAF jamming capability. Furthermore, the Israelis had little to no experience flying against them. Consequently, multiple SAM systems—along with the ZSU-23-4 and other anti-aircraft guns—formed an array of known and unknown threats ranging the spectrum of aerial approaches from low to high altitude.¹³¹ This conglomeration of air defenses delivered a stunning blow to the IAF in the first days of the October War and prevented it from disrupting the Egyptian crossing into the Sinai.¹³²

Nonetheless, the shock that produced the desired effect on the IAF resulted not from a skillful use of weapon systems but from the unprecedented quantities in which the Egyptians employed them. Commenting during the war on the struggles facing the air force on the southern front, Israeli Defense Minister Moshe Dayan speculated that not even Moscow or Hanoi could claim an air defense screen more dense than the one Egypt had in place over the Suez Canal. When it came to actual expenditure, density set the stage for extravagance. The number of SAMs fired by the Arab states in the first three days of the conflict nearly matched the total in NATO's European stocks at the time.¹³³ According to scholar Kenneth M. Pollack, the tempest of Egyptian missiles and anti-aircraft gunfire downed roughly 40 Israeli planes. By this calculation, those taking aim at the IAF over the Sinai fired 190 SAMs for every aircraft they managed to shoot down. Strictly speaking, this rate of performance was awful. Little can be said in favor of Egyptian marksmanship, especially given that the Soviets figured on expending only five to 10 SAMs to achieve the same result. Unsurprisingly, one estimate attributed the loss of as many as 60 Egyptian planes to ground fire from their *own side*.¹³⁴

Still, Egypt's air defenses proved sufficient in unsettling the Israelis psychologically and triggering senior commanders to call a temporary halt to sorties near the Canal Zone. Indeed, for their role in protecting the crossing and subsequently the bridgeheads, missile and anti-aircraft gun batteries deserve some credit for an achievement that later bore fruit in negotiations. For this reason, Pollack characterizes the Egyptian air defense effort in the 1973 war as "highly effective" but goes on to describe it as "terribly inefficient" as well. He qualifies his assessment owing to the poor marksmanship of missile and gun crews, itself a natural consequence of operators not fully understanding their weapon system.¹³⁵

Why was the accuracy of Egypt's air defenses so appalling that it essentially compelled the high command to compensate for this shortcoming with sheer quantity? For one thing, the Egyptians had long relied on Soviet expertise to operate and maintain its arsenal of sophisticated SAMs. In the so-called War of Attrition from 1969 to 1970, Egypt had sought to harass Israel through a prolonged campaign of low-intensity military actions along the canal. Operations generally took the form of air strikes, commando raids and sporadic artillery bombardments. An unintended result of this exchange of intermittent blows was the steady attrition of the Egyptian air force and the erosion of its defensive belt of SAM-2s. Indeed, engagements with the IAF became so consistently lopsided that the Egyptian high command grounded the air force and opted to defend the country's airspace exclusively with its air defense network. Though this shift likely spared several planes and pilots, it did little to dissuade the IAF. Continued Israeli pressure on Cairo prompted the regime to ask for enhanced Soviet assistance, and Moscow willingly obliged. By March 1970, Soviet crews had arrived with newer SAM systems and a host of radar-guided anti-aircraft guns. Soon thereafter, they assumed almost complete responsibility for Egypt's ground-based air defense.¹³⁶

Thus, despite the opportunity to acquire valuable combat experience in the War of Attrition, Egyptian familiarity with the employment of SAMs remained relatively low. The Soviets increasingly carried out the balance of air defense duties, and, before their serious commitment, the chief concern of many Egyptian SAM crews had been survival. One Soviet officer complained about how Egyptian air defenders would fire a missile and then “promptly vacate their work stations,” for it had “never occurred to them that a missile needed to be guided in flight.”¹³⁷ Such anecdotes perhaps minimize the courage that typical Egyptian crews displayed under fire, but they nonetheless provide some indication of their mindset, as well as an idea of the kinds of training challenges that likely persisted into the 1970s.¹³⁸ In the SAM-6, the Egyptian military had access to even better state-of-the-art air defense equipment. Still, as a newly-fielded system, there is no reason to believe that its crews handled them with a greater level of expertise during the 1973 conflict. A focused training regimen may have helped to address this shortcoming. The Egyptian army’s fastidious efforts to improve proficiency in the firing of its antitank weapons are well-documented.¹³⁹ But, unlike RPG-7s and Sagger missiles, costly and sophisticated air defense systems do not easily lend themselves to repetitious live-fire target practice.

The case of Egyptian air defense suggests a certain pattern of adaptation for militaries that labor under deficiencies in technical skill. With its limited and specific aims, Sadat’s strategy inspired an operational approach carefully tailored to avoid the challenges of combined-arms maneuver warfare—a longstanding weakness of the Egyptian military. This approach compensated for the tactical ineptitude of the army’s junior leaders (and, to a lesser extent, its poor maintenance). In the same way, the high command hoped that thickening its air defense network with more weapon systems would offset the inaccuracy of its missile and gun crews.

This path of adaptation was clearly formulated in advance of the campaign’s execution. The plan’s success depended on Egypt’s ability to prevent the IAF from disrupting the crossing and destroying lodgments on the east bank of the canal. The forces to establish this protective umbrella had to be marshaled ahead of time, and their concentration along the canal made for a density of weapon systems that defied doctrinal norms. Ammunition stockpiles attested to the intentionality behind this undertaking—as did the Egyptian decision before hostilities commenced to not vigorously contest Israeli control of the skies with their own aircraft. Lack of technical familiarity with their air defense weapons kept the Egyptians from exploiting the capabilities of those weapons to the fullest extent. Poor marksmanship was a symptom of this shortcoming, and the high command sought to compensate for it by maximizing the quantity of projectiles fired.

Again, this deliberate act of compensation—despite its inherent inefficiency—proved effective in the crucial opening phase of the conflict. The crossing went forward and, supported by an air defense network primed to launch staggering amounts of ordnance at Israeli planes, quickly achieved Sadat’s chief goal. Assigned with the task of protecting a set of shallow bridgeheads for a limited time, this network could focus its firepower over a relatively confined geographical area. What is more, it possessed weapon systems able to strike at varied ranges and altitudes and, in the SAM-6 and SAM-7, contained sensor technology that thwarted IAF electronic countermeasures. This combination of challenges surprised Israeli pilots and confronted them with multiple threats simultaneously.¹⁴⁰

Despite accomplishing some measure of success in this instance, the Egyptian approach to solving operational problems stemming from inferior technical skills had restrictive transferability. Styled to a specific set of circumstances, it could not be easily replicated elsewhere or

sustained when conditions changed (as, in fact, they did several days into the war). Analysts investigating the Sinai campaign found the Arab missile density on that front “unrepeatable . . . even by Soviet standards.”¹⁴¹ If the Soviet Union deployed all of the SAMs it possessed at the time (around 10,000) in a conflict with NATO in Western Europe, the density of the missile screen would still fall short of that afforded to the Arab states in the October War.¹⁴² The case of Egyptian air defense demonstrates the limits to certain modes of adaptation.

Greater familiarity with the technical workings of a weapon system naturally allows for the more efficient employment of that system, as well as an enhanced ability to maximize its capabilities.¹⁴³ If the skills of operators and crews fall short in this regard—and especially if they suffer by comparison to those of a prospective adversary—then it remains for a military on the brink of war either to use a weapon system poorly or to cast off the pall of resignation and find a way to compensate. In the 1973 conflict with Israel, qualitative disadvantages drove Egypt to compensate, and it did so in at least two areas—tank mobility and air defense accuracy. It seems reasonable to extend this argument in order to explore the connection between technical clumsiness of the kind that hampers sound weapons employment and slipshod maintenance practices. There is clearly a positive correlation here, one the Egyptian case affirms.

More important, skill deficiencies related to maintenance—or an institutional disregard of it—shed light on how a nation’s armed forces might adapt as a means of compensation. First, operational and tactical workarounds would likely be designed and implemented at higher levels in the organization and not at the small-unit or individual level, where the skills often required for improvisation would be lacking. In addition, adaptive solutions developed under these constraints would necessarily be less flexible in application. They could be effective, say, in carefully-tailored situations, but then lose their relevance once the advantage of surprise fades, the conflict becomes prolonged or the enemy adapts countermeasures.

Maintenance Proficiency and Adaptation in War

Just as maintenance proficiency shapes adaptation within the context of prewar preparation and planning, so a similar relationship exists once hostilities have begun. Again, the nature of the connection warrants careful consideration. It is not enough to conclude that one belligerent adapted well under fire while the other fell victim to paralysis or simply sat idle. Pursuing this line of inquiry further by exploring *why* efforts to adapt succeeded or failed bears more analytical fruit.

In *Military Adaptation in War*, historian Williamson Murray takes this nuanced approach and consequently illuminates the process of organizational learning during combat. He highlights the IDF’s mixed record on wartime adaptation in 1973, arguing that Israeli formations at the tactical level recovered fairly quickly (though at great cost) and went on to meet the Egyptians’ antitank missile challenge. Surprised not so much by the weapon as by its manner of employment, IDF leaders assessed the threat and took steps to implement a solution. They restored the infantry-armor-artillery team to an army that had essentially abandoned a combined-arms approach. Murray attributes this organizational agility to widespread combat experience among officers and noncommissioned officers, as well as to rigorous small-unit training of the sort that had conditioned Israeli soldiers to exercise initiative under stress. At the operational level, however, the IDF proved less responsive. Senior commanders and staff entered the war ill-equipped to direct multiple division-sized organizations toward a common objective in battle. Cognitively unprepared, they lacked a coherent operational concept suitable

to the unanticipated problems facing them on the southern front and clung to prewar assumptions long after the grounds for the validity of those assumptions had eroded.¹⁴⁴

Murray's analysis of the IDF in the 1973 Sinai campaign comes at the end of a broader study of several cases in which he identifies factors that drive successful adaptation in peace and war. Among them, Murray includes "imagination and a willingness to change"; "organizational cultures that encourage the upward flow of ideas and perceptions as well as direction from above"; senior leaders who incite their subordinates "to seek out new paths"; and military education that lays the foundation for intellectual understanding to inform instinct and govern action.¹⁴⁵ The relative strength and weakness of these factors combined to shape the overall pattern of IDF adaptation in 1973: success at the tactical level but failure at the operational. As Murray summarizes, "initiative and flexibility could not make up for the lack of education and conceptualization."¹⁴⁶ Along these lines, scholar Meir Finkel credits the IDF's recovery from the doctrinal surprise of Sagger missiles to a "culture of improvisation"—particularly evident at the battalion level. The Israeli army adapted from a base of technical and tactical competence to restore "weapons and unit diversity" (which is to say, it adopted a combined-arms approach to military operations once again).¹⁴⁷ And remarkably, it did so during wartime.

The Egyptian armed forces did not emerge from the 1973 war with a reputation for exhibiting a culture of improvisation. Quite the contrary. Still, they *did* adapt, and the fact that they did so illustrates the need for a nuanced assessment of adaptation patterns. One can see elements of Murray's framework in select examples of Egyptian military conduct leading up to the conflict. The engineers' deployment of high-powered water pumps to blast passageways through the sand berm of the Bar-Lev Line demonstrated ingenuity, as did the elaborate deception operation that supported the crossing. Likewise, Egyptian senior leaders had the flexibility of mind to evaluate the two competing air forces and, finding the balance grossly unfavorable, opted to scale back the activity of their own. They assigned the mission of keeping the IAF in check to a corps of air defenders, who themselves had adapted to the handicap of hopelessly poor marksmanship by planning to saturate the airspace over the canal with exorbitant amounts of ammunition. Finally, eschewing traditional Soviet offensive doctrine, the high command adopted a creative operational approach that deliberately played to the strengths of its soldiers, avoided or minimized their weaknesses and simultaneously accomplished Sadat's political objectives. Given this evidence of adaptation, it is not a stretch to argue that, in some capacity, the Egyptians displayed the will to change as well as imagination and a readiness to exploit new ideas. Indeed, on the eve of hostilities, the members of the Egyptian high command seemed especially adaptive compared to their Israeli counterparts, whose faith in a "civilization gap" bolstered a false sense of their country's invulnerability while blinding them to the near-term possibility of an Arab attack.¹⁴⁸

Of course, the record of Egyptian adaptation must be qualified. Senior commanders explicitly discouraged individual initiative in training exercises prior to the campaign.¹⁴⁹ They envisioned success as resulting from strict adherence to a script that concluded before the war ran its full course. When the script ended, so did the string of operational successes. So, what does the nuanced pattern of adaptation suggest when the analysis is extended from the realm of operations to the realm of maintenance?

Before the war, both Israel and Egypt displayed adaptability through equipment modifications aimed at aligning weapon system capability with tactical demands or personnel skill levels. For example, the French Mirage had been designed for college-educated pilots. To

compensate for the fact that most Israeli pilots received only a high-school education, the IAF modified the widely-exported aircraft. Over 600 changes in specifications ensured that the skills required to operate the advanced fighters were consistent with the technical attributes of the men slated to fill their cockpits.¹⁵⁰ A more complex case of prewar adaptation was the construction of the Bar-Lev Line during the War of Attrition. This elaborate system of fortifications, underground command bunkers and local repair facilities affirmed Israeli resolve to hold on to its territorial gains while reducing exposure to casualty-producing artillery bombardments. The doctrinal adaptation lay in the compromise that addressed these two competing strategic concerns.¹⁵¹ Tactically speaking, Israel's Southern Command established the string of positions along the canal to warn of Egyptian commando raids or a major offensive. To disrupt the latter, the Israelis attempted to supplement the line with an array of pipes connecting oil storage tanks to the water's edge. It was hoped that soldiers manning the fortifications could mechanically discharge a thin film of oil, ignite it and turn sections of the canal into bands of flame. Engineers determined that these systems—though ingenious—were impractical. Nonetheless, the two they managed to install had a marked psychological effect on the Egyptians, who remained unaware of the project's abandonment for some time.¹⁵²

Just as the Israelis explored technical adaptation as a means to prevent an assault across the canal, Egyptians tried the same to ensure its success. Sadat's engineers made slight structural changes to the motley assortment of British and Soviet bridging equipment they possessed. Performed with the imminent crossing operation in mind, these modifications made bridge sections interchangeable and thus facilitated rapid bridge construction and repair.¹⁵³ Following the ouster of Soviet advisors in 1972, Egyptian technicians applied what to them seemed only common sense and adjusted the Warsaw Pact vehicles in their formations to better meet the demands of war in the Middle East. The hot, dry climate and ubiquitous grit of desert terrain wore down engine components and tank tracks at a much quicker rate than conditions in Central Europe. Journalist and defense commentator Edgar O'Ballance mentions that the Egyptians modified tanks with the effect of quadrupling track mileage on certain models. They likewise took steps to reduce engine and transmission wear and installed grenade canisters to the exterior of the T-54s in their arsenal. While he neglects to elaborate on the true significance or difficulty of their implementation, O'Ballance also alludes to improvements to SAM and radar equipment.¹⁵⁴ Needless to say, adaptation in *this* "interwar period" was not a one-sided affair.

During the war itself, however, Israel's army and air force proved far more nimble in their efforts to confront unexpected military challenges. The IAF's multifaceted response to Egypt's air defenses—the SAM-6, in particular—yielded only marginal success but was impressive owing to the variety of improvisations it entailed and the relative speed of their implementation. Israeli pilots had never flown against the Soviet-made SAM-6. Decidedly mobile and a threat to aircraft cruising at both high and low altitudes, this state-of-the-art missile system provided little warning upon launch and contained sensor technology that thwarted Western electronic countermeasures. To mitigate the danger that such missiles posed to sorties against Egyptian crossing sites and bridgeheads, the IAF deployed helicopters to detect the launchers and pinpoint them for immediate counterstrikes. Helicopters themselves became targets through this unconventional practice, but their labors gave fixed-wing aircraft a second or two of reaction time that they otherwise lacked. While some methods delivered earlier warning, others sought to distract. Drones provided by the United States for photo-reconnaissance

missions during the War of Attrition were sent up in the 1973 conflict as decoys to draw SAM fire. Pilots also developed aggressive evasion tactics that involved a high-altitude approach followed by a near-vertical dive toward the launcher position, thus avoiding the SAM-6's low and flat initial trajectory.¹⁵⁵ Hence, organizational flexibility demonstrated by the employment of weapon systems in nonstandard roles, coupled with well-honed skills that enabled complicated aerial maneuver, afforded pilots some reprieve.

So too did technical modification rooted in equipment familiarity. In an attempt to fool the SAM-6's sensors, the IAF outfitted aircraft to release concentrations of chaff. This took some jury-rigging, however, because Phantom fighters were not built with chaff dispensers. As a workaround, ground crews stuffed thin metallic strips into air brake wing slots. In flight over likely missile sites, pilots briefly applied the air brakes and discharged a cloud of chaff. Concretely, such ad hoc measures had limited value in the running battle against integrated air defenses.¹⁵⁶ Nonetheless, they reflected well on the IAF institutionally, both in terms of the initiative and creativity displayed and the close scientific-military cooperation their implementation required.¹⁵⁷

In contrast, one searches in vain for an example of Egyptian adaptation developed and enacted amid the stress and strains of the Sinai campaign. To be sure, decisions to improve the chances of survival by curtailing risky activities—like engaging in air-to-air combat—amount to adaptation in a broad sense. Yet organizational changes of the kind observed in the Israeli armed forces fall into a different class. Critical to adaptation in war—especially short wars—is the quality of speed. The productive relationship between Israel's military and scientific communities and the country's underlying culture of improvisation helped address emerging problems relatively quickly.¹⁵⁸ So did a military culture that valued maintenance competence and supported the training of its mechanics and operators accordingly.

Historian Williamson Murray has explained successful (though not bloodless) Israeli adaptation as the result of an ability to shift tactical frameworks midstream from a solid foundation of combat experience and rigorous, realistic training.¹⁵⁹ It seems fairly clear as well that militaries develop and implement much needed technical changes by adapting from a baseline of equipment familiarity. In the October War, a strong correlation appears between the familiarity that crews had with the operation of their weapons systems and overall maintenance proficiency. The IDF illustrates the positive, its adversaries the negative. *An understanding of how a military regards and conducts maintenance, then, sheds light on the extent to which it will be able to improvise in wartime. Maintenance proficiency serves as an indicator for how fast and how frequent new techniques can be developed and implemented and whether the expertise exists to apply them widely across the force as it fights.*

The IDF's ability to leverage its technical competence went beyond equipment modification. Combining such proficiency with the initiative inherent in a culture of improvisation, Israeli commanders created new formations and readily altered maintenance practices to accommodate shifting wartime requirements. In an effort to stanch mounting losses of armored vehicles early in the war, division commander Bren Adan established a checkpoint near the front. Here, officers arranged for casualty evacuation and formed new tank crews from the survivors. Tanks rolling into the checkpoint were serviced on the spot by mechanics. Those too damaged to be fixed immediately were sidelined to await later repair. Adan recalled “considerable improvisation at the checkpoint” as leaders matched able crews with functioning vehicles,

eyeing a quick return to the fight for both. Satisfied with this ad hoc measure, the division commander ordered similar checkpoints set up in each subordinate brigade sector.¹⁶⁰

Later, after the tide had turned and Adan's unit had crossed the Suez Canal into Africa, he faced a comparable problem. Pressing hard to complete the encirclement of the Egyptian Third Army before the imposition of a ceasefire, Adan found that he lacked sufficient force to close the net. Infantry reinforcements had arrived from the Golan front, but no military vehicles. These troops required mobility for the task at hand, so Adan corralled enough of the Egyptian armored personnel carriers that his division had captured to form a provisional infantry brigade. This outfit joined the battle alongside the three armored brigades already under his control.¹⁶¹ This account lends credence to historian Trevor N. Dupuy's separate finding that the IDF recovered and went on to employ about 300 repairable Arab tanks during the conflict.¹⁶²

These examples of improvisation stem from the initiative and organizational creativity of Israeli commanders and their staffs, but the technical skill of crewmembers and mechanics made their implementation possible. Familiar enough with their own equipment, Israeli soldiers could transfer that knowledge and apply it to the maintenance and operation of analogous weapon systems—even ones that began the war on the opposite shore. Of course, this flexibility pertained to the care of Israeli hardware as well. Confronted with the prospect of an unexpectedly prolonged conflict, the IAF adjusted its aircraft maintenance program. Delaying serious maintenance checks and services until hostilities ended had worked in the Six Day War of 1967, but such concepts proved impractical in 1973. Instead, to maximize the number of sorties per day, the IAF adopted rotational maintenance schedules akin to those followed by civilian airlines.¹⁶³ Rapidly-conceived techniques to provide responsive vehicle repair, the impromptu creation of formations to fill a tactical need and the ability to employ different weapon system models or to shift almost seamlessly to new maintenance programs—these Israeli examples of organizational adaptation during war all rely on equipment familiarity rooted in technical skill at the lower echelons. Their implementation helps to illustrate the connection between maintenance and operations, particularly the way in which maintenance shapes a military's pattern of adaptation.

In contrast to the IDF, Egypt's armed forces performed poorly in the area of maintenance. This came as no surprise in retrospect—perhaps least of all to the Egyptian high command, whose members designed a campaign that deliberately sought to avoid known shortcomings in the country's army and air force. Nonetheless, the poor maintenance capability of Egypt's military meant that its options for technical adaptation were limited. The high command could put top-down organizational solutions in place rather easily in peacetime. But once war commenced and the forces of fog and friction began to churn the Sinai sands, changes of tactical significance would have had to originate through initiative from the bottom up and would have taken individual skill at junior levels to implement. Such changes proved elusive.

Conclusion and Summary of Maintenance-Related Insights

This paper has not aspired to offer another history of the October War. It has attempted instead to analyze the conflict with a view toward illuminating the relationship between operations and sustainment, and, more specifically, between operations and maintenance. Exploring Egyptian and Israeli military performance in the 1973 conflict provides an avenue to consider the implications of each side's approach to maintenance. How the armed forces of Egypt and Israel understood the relative importance of maintenance as a factor of wartime success and how they assessed their relative strength in that area shaped their approach to military

operations. Furthermore, actual maintenance capability went on to influence the conduct of operations as they unfolded (and not necessarily in parallel ways). Recognizing their weakness in maintenance capability, the Egyptians sought to improve technical skills in their officer and enlisted ranks, but such efforts could only go so far in a fixed period of time. Resolved to win back the Sinai yet mindful of their armed forces' qualitative shortcomings, Sadat and his top generals developed a plan to compensate for those shortcomings and thus minimize their operational impact. Israel, for its part, relied heavily on superior maintenance capability to address its vulnerable geostrategic position and its adversaries' quantitative advantage. In the case of both Egypt and Israel, maintenance capability also distinctly influenced patterns of military adaptation—during the preparation and planning stages, as well as in the midst of actual hostilities. The following insights emanate from this maintenance-focused examination of Egyptian and Israeli military performance during the October War.

- Logistical assessments must be nuanced and pursued to sufficient technical depth. For example, the ability to maintain equipment and the ability to move and supply forces are closely related in terms of function, but they rely on different sets of skills for execution. Thus, a military's competence in performing them may vary.
- In assessing militaries, one can simply list strengths and weaknesses, but the effect of this balance—whether strengths or weaknesses *really matter* (and how)—depends on a consistency between the capabilities of an army or air force and what it intends to accomplish. In the context of this internal consistency, routine metrics will not tell the whole story and may in fact be misleading. A glaring weakness in one contingency may not be a weakness at all in another. Israel, for example, allowed its assessment of Egyptian air force readiness to blind military leaders to the near-term possibility of a limited campaign reliant on a protective air defense umbrella. Simplistic, superficial maintenance assessments are vulnerable to deception and/or self-deception. On the other hand, military systems deriving latent power from an internal consistency of ends, ways and means are susceptible to disruption. Subject to the designs of a thinking enemy and the unremitting fog and friction of war, this internal consistency or alignment is fragile indeed. The fabric of Egypt's military system, for example, unraveled as the war grew more prolonged and as objectives expanded to outstrip capabilities.
- There is a link between cultural predisposition, maintenance practices, operational doctrine and weapons design. Whether the dominant trend in a military system favors centralization or decentralization depends very much on culture. Culture also poses a formidable obstacle to incremental change. Efforts at improving maintenance performance need to be deliberate and precise if they face cultural barriers—as the Egyptians did between 1967 and 1973.
- A military may use both improvement and compensation to close a capability gap. The motivation and direction of *improvement* are easier for a competitor to discern and predict, while the many possible paths toward *compensating* for known weaknesses are much less conspicuous. Thus, compensation may be a more effective approach for the military persuaded to pursue it, but its effectiveness seems limited to specific circumstances in time and space.
- No military corners the market on the process of adaptation, but military organizations tend to adapt in different ways and with mixed success. Patterns of adaptation vary with

military culture and capability *and* with the nature of the knowledge involved (be it technical, organizational or doctrinal). A culture of improvisation, combined with maintenance proficiency, enabled the IDF to leverage equipment familiarity at lower echelons and thus adapt in war as well as in peace. By comparison, Egyptian wartime adaptation seemed hindered by a dearth of technical skill and a cultural attitude that dampened initiative.

- Poor maintenance serves as an indicator of limited technical skill among operators and suggests that crews are unable to take full advantage of their equipment. Consider the inability of the Egyptian army to exploit the tank's mobility or how it operated a bristling arsenal of SAMs with a handicap imposed by hopelessly poor marksmanship. Limited technical skill at lower levels also works against the process of technical adaptation from the bottom up. Militaries saddled with this problem look to top-down organizational adaptation for solutions. The Egyptians adapted on a relatively large scale so as to reduce the effect of their weaknesses, launching an infantry-centric assault into a narrow slice of the Sinai and resorting to enormous air defense munitions expenditures to overwhelm Israeli pilots.
- Superior maintenance is one way to address an adversary's quantitative advantage. In the case of Israel, it provided a kind of flexibility that compensated for limited strategic depth and enabled operational options. The IDF routinely recovered and repaired damaged tanks and then funneled them back into the fight. This ability kept Israeli tank strength at levels sufficient to execute and sustain a counterattack across the canal and into Africa. Incorporating captured and repaired Arab armored vehicles into provisional units also contributed to this end, as did a U.S.-sponsored airlift that mitigated risk through the promise of additional resources should a fluid, closely-fought situation demand them.
- An adversary's maintenance system may serve as an indicator of its expectations for an imminent war's duration. This proved to be the case for both Egypt and Israel, whose leaders anticipated a relatively short conflict.

Epilogue: Relevance for the U.S. Military in Future Competitions

What do these insights from a 1973 case study mean for the U.S. defense and intelligence communities today? In a 2012 assessment of defense priorities, then-Secretary of Defense Leon Panetta formally articulated a "rebalance" of U.S. military strength toward the Asia-Pacific region.¹⁶⁴ Strategic guidance since then has highlighted China's rise to regional power as a long-term challenge to U.S. economic and security interests; the most recent DoD annual report on China's military modernization provides a foretaste of the means by which this challenge may come.¹⁶⁵ Only recently, U.S. officials have begun to classify the pattern of tense and often confrontational interactions with China as a competition, but commentators in China have long taken that view.¹⁶⁶ Regardless of how one characterizes the relationship, the emergence of China and its ambiguous strategic intentions call for a deeper understanding of the People's Liberation Army (PLA) and how this force intends to safeguard or advance the interests of its political masters.

Although American security and intelligence analysts have learned much about the PLA in recent years, it almost goes without saying that substantial gaps remain. There is a sense at least that the United States knows much less about China than it did about the Soviet Union during the Cold War, not least because rich insights on the latter came as the result of a decades-long

focus on a peer competitor. The security environment may lack a compelling Cold War context at present, but that does not peremptorily invalidate parallels between the Soviet armed forces and the PLA as somehow distorted or misleading. As they seek to deepen their understanding of China and the PLA, U.S. analysts can learn from their Cold War-era predecessors and pursue similar lines of inquiry without gazing through a Cold War lens.

Works that went beyond the Soviet Union's technological capabilities to explore the more elusive (and revealing) qualitative aspects of personnel skills, training and education, military organization and doctrine and the influence of culture proved especially helpful. RAND analyst Herbert Goldhamer, for example, alluded to the U.S.S.R.'s obsession with improving the education level of its conscript force and described "preinduction military training" in detail. A massive undertaking that targeted youth in the two years before their call up, preinduction military training imposed enormous costs in terms of time, money and manpower.¹⁶⁷ Goldhamer determined that, in spite of its gross inefficiencies, the program yielded a positive outcome for the Soviets overall. The effort itself was quite telling, though. Moscow's concern regarding the quality of its recruiting pool was evident. Expensive programs and strong intentions could not overcome cultural predispositions and deep-rooted economic and social tendencies. Failure to properly manage and account for equipment and to treat it with care ran rampant at preinduction military training sites, as it did throughout much of the Soviet economy.¹⁶⁸ In the active forces, initiative among subordinates was encouraged but rarely demonstrated—given the greater emphasis on "undeviating adherence to regulations and instructions."¹⁶⁹ According to Nathan Leites—one of Goldhamer's contemporaries at RAND—Soviet commanders considered "improvisation" a pejorative term since it seemed to indicate, above all, a lack of preparation.¹⁷⁰ As Goldhamer wryly observed, "prescriptions to encourage the independence, initiative, and 'creativity' of officers do not suffice to produce them in a society where precisely these attributes are often penalized."¹⁷¹ "Technological backwardness" not only hampered training but also affected the employment of advanced weapon systems. Goldhamer, for example, saw evidence of officers displaying "excessive reserve when faced with unfamiliar technology."¹⁷²

Shortcomings in technical skills and key leadership attributes—like initiative—reverberated throughout the Soviet military system to affect maintenance capability, which in turn influenced operations. U.S. and Soviet maintenance doctrine during the Cold War shared several commonalities, including the imperative to provide continuous forward support to frontline units and the ideal of conducting repairs as far forward as possible. But the Soviets lacked the skilled mechanics and crewmembers to put their doctrine into full practice.¹⁷³ They improved personnel quality to the extent that they were able, and this effort—a point of pride for Moscow—was not trivial. Yet improvement alone could not offset the debilitating effects of limited technical skills throughout the military, a reflection of Soviet society. To fight and win the war it envisioned with the means at its disposal, the Soviet high command compensated with an operational approach that emphasized reinforcing success rather than reconstituting spent formations. One American commentator concluded,

Unlike the U.S. Army, the Soviet Army can afford greater attrition and, consequently, less responsive repair and recovery capability because it claims superiority in numbers. It is questionable, however, whether this will provide solace to Soviet battalion commanders needing maintenance support during battle.¹⁷⁴

Missing from this assessment is the unvarnished reality that "solace" for frontline tactical leaders mattered little to the high command. The Soviets approached maintenance very differently

from the U.S. Army and its NATO allies, and this different approach was embodied in compensatory measures woven into their military's organization, operational doctrine and even tank design.

So, what judgments along these lines can be made about the PLA's approach to maintenance? Chinese doctrine highlights the importance of maintenance in modern war, the growing difficulty of recovering and repairing sophisticated equipment on a lethal battlefield, and the need for skilled soldiers to conduct this task. In their seminal work, *Science of Military Strategy*, the authors explain,

The experiences of past wars have demonstrated the fact that the quality of technical maintenance has direct impact on the perfect performance of the equipment and weapon systems, and furthermore, has bearing on the success or failure of the strategic operations. . . . The combat damage rate of equipment and weapon systems has increased greatly. Meanwhile, since the causes of the damage have changed from the previous hard-kill power to a combination of hard-kill and soft-kill power, the categories of the damages to equipment and weapon systems become more complicated. Since technical support has to cope with not only huge amount[s] of technical problems with hardware, but also problems with software, the difficulties in recovering the damaged equipment and weapon systems have been increased significantly.¹⁷⁵

In the Chinese view, a combat environment characterized by heavy attrition, advanced weapons and fast-paced conflicts of short duration demands unprecedented levels of technical skill. Their own analysis of the 1973 Arab-Israeli War concluded as much: the IDF's ability to repair and return damaged tanks to the battlefield essentially changed the outcome of the campaign.¹⁷⁶

Aware of its shortcomings in this area, the PLA has embarked on a sustained effort to improve the quality of its soldiers in order to meet the demands of "local wars under high-tech conditions." Beginning in the 1990s with modifications to the conscription policy, personnel reforms have included rebalancing the force to raise the ratio of noncommissioned officers and recruiting college graduates into the enlisted ranks. Such programs involve daunting organizational changes. Seemingly intractable problems of Chinese society—like poor education levels among rural youth, bureaucratic squabbling and cultural barriers to individual initiative—will only delay (if not thwart) the effects of reform implementation. Given the obstacles in its path, the PLA's long march to enhanced personnel quality will be slow but will also be in step with the broader modernization effort now underway.¹⁷⁷

The Chinese military has extended its push for qualitative improvement to the logistical system as well. Although the fielding of advanced arms and equipment accounts for a larger percentage of the defense budget, the PLA's military logistics modernization has yielded significant gains.¹⁷⁸ Serious limitations remain, however. And they particularly affect China's ability to project power beyond its borders.¹⁷⁹ Nonetheless, one seasoned American analyst of the PLA summarizes,

The trends in China's military logistics modernization appear consistent with advanced capabilities that have already been mastered by the United States and other militaries. Although the PLA trails well behind more advanced military logistics systems, it does appear to be on the right track for significantly advancing China's military logistics capabilities.¹⁸⁰

Another scholar echoes this trend toward steady improvement, finding that “strategic and doctrinal revisions in recent years all point to a rather straightforward path ahead for PLA logistics.”¹⁸¹ As examples, he goes on to mention interservice logistical integration, the use of information “system-of-systems,” and “the general realization that a military being tasked with an increasingly diverse set of tasks and missions requires a logistical system that is flexible, distributed, and nimble.”¹⁸² Based on these assessments, one comes away with the impression that the PLA intends to model its logistical system (including maintenance) on that of the U.S. military and is improving accordingly—which is to say, just as expected.

Insights derived from a study of the 1973 Arab-Israeli War suggest treating this viewpoint with rigorous skepticism. Following the debacle of their 1967 defeat, the Egyptian high command acknowledged the general deficiency of technical skills throughout its forces and sought to make improvements. Measures taken along these lines introduced better-educated troops into the ranks and moderately elevated technical competence. However, it was not enough to offset persistent qualitative disadvantages vis-à-vis the Israelis. Maintenance performance remained abysmal, for example, and seemed impervious to improvement, given certain cultural impediments. Thus, in its plan for the assault across the Suez Canal, the high command compensated for known weaknesses. In doing so, it not only sidestepped the effects of glaring shortfalls in technical skill, but also dramatically surprised its adversary, who had all but written off the prospect of war at that time.

The PLA today recognizes that its personnel lack the technical skills required to fight and win wars under “high-tech” conditions and is over a decade into a multigenerational venture to improve the quality of its soldiers and systems. Several obstacles—many particular to Chinese society and culture—threaten to disrupt this path. Consequently, it seems naïve to think that the process will continue to take the form of a steady uphill climb to parity with Western militaries such as the U.S. armed forces. With the end of the Cold War came access to sources that revealed stark and startling differences between how the United States and Soviet defense communities approached military problems. When it comes to the Chinese, differences in approach stand to be even greater.¹⁸³ And the Chinese penchant for addressing technological deficiencies through stratagem will only amplify this cognitive distance.¹⁸⁴ How might the PLA compensate for a shortage of personnel skills and the potentially disrupting influence of culture? How might these compensatory measures work to its advantage, and what vulnerabilities could they lay bare? U.S. analysts are currently engaged in a patient endeavor to understand China, but a more focused look at the understudied topic of PLA maintenance may yield unforeseen insights to these questions and thus ward off surprise of the most unpleasant kind.

Notes

- ¹ Quoted in Susan M. Puska, “Taming the Hydra: Trends in China’s Military Logistics since 2000,” in *The PLA at Home and Abroad: Assessing the Operational Capabilities of China’s Military*, eds. Roy Kamphausen, David Lai and Andrew Scobell (Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 2010), 553.
- ² Peng Guangqian and Yao Youzhi, eds., *Science of Military Strategy* (Beijing: Military Science Publishing House, 2005), 280.
- ³ Quoted in Department of the Army, Army Doctrine Publication (ADP) 4-0, *Sustainment* (Washington, DC: U.S. Government Printing Office, 31 July 2012), iii, 15.
- ⁴ Department of the Army, Army Doctrine Publication (ADP) 3-0, *Operations* (Washington, DC: U.S. Government Printing Office, 6 October 2017), 6.
- ⁵ ADP 3-0, 4.
- ⁶ ADP 3-0, 15.
- ⁷ James A. Huston, *The Sinews of War: Army Logistics, 1775–1953* (Washington, DC: U.S. Government Printing Office, 1966), 655.
- ⁸ Charles R. Shrader, ed., *United States Army Logistics, 1775–1992: An Anthology* (Washington, DC: U.S. Army Center of Military History, 1997), 1:9.
- ⁹ ADP 4-0, 1; ADP 3-0, 16.
- ¹⁰ George C. Thorpe, *Pure Logistics: The Science of War Preparation*, rev. ed. (Washington, DC: National Defense University Press, 1986), 10–11.
- ¹¹ Thorpe, *Pure Logistics*, 10–11, 13.
- ¹² Thorpe, *Pure Logistics*, 2.
- ¹³ Kenneth M. Pollack, *Arabs at War: Military Effectiveness, 1948–1991* (Lincoln: University of Nebraska Press, 2002), 568.
- ¹⁴ Trevor N. Dupuy, *Elusive Victory: The Arab-Israeli Wars, 1947–1974* (New York: Harper and Row, 1978), 549–50. The IAF flew approximately 10,500 sorties with 360 fixed-wing combat aircraft in its inventory; the air forces of Egypt, Syria and other Arab states flew less than 10,000 sorties despite beginning the war with over 1,000 aircraft of similar class (Dupuy, *Elusive Victory*, 606).
- ¹⁵ Anthony H. Cordesman and Abraham R. Wagner, *The Arab-Israeli Conflicts, 1973–1989*, vol. 1, *The Lessons of Modern War* (Boulder, CO: Westview Press, 1990), 103–104; Riad Ashkar and Haytham al-Ayyubi, “The Middle East: The Military Dimension,” *Journal of Palestine Studies* 4, no. 4 (Summer 1975): 4–5; Avraham (Bren) Adan, *On the Banks of the Suez: An Israeli General’s Personal Account of the Yom Kippur War* (Novato, CA: Presidio Press, 1980), 14–15.
- ¹⁶ Edgar O’Ballance, *No Victor, No Vanquished: The Yom Kippur War* (San Rafael, CA: Presidio Press, 1978), 87–89, 344.
- ¹⁷ Dupuy, *Elusive Victory*, 470; Pollack, *Arabs at War*, 129–30.
- ¹⁸ Dupuy, *Elusive Victory*, 414–16.
- ¹⁹ Pollack, *Arabs at War*, 567.
- ²⁰ A. B. Zahlan, “The Science and Technology Gap in the Arab-Israeli Conflict,” *Journal of Palestine Studies* 1, no. 3 (Spring 1972): 27.

- ²¹ Zahlan, “Science and Technology Gap,” 27.
- ²² Pollack, *Arabs at War*, 567–68.
- ²³ Pollack, *Arabs at War*, 125.
- ²⁴ Malcolm Chambers and Lutz Unterseher, “Is There a Tank Gap?: Comparing NATO and Warsaw Pact Tank Fleets,” *International Security* 13, no. 1 (Summer 1988): 36. Soviet armored vehicles may have been less complicated mechanically (and thus more durable under certain conditions), but they were not designed for warfare in the Middle East. Tracks and track pads, for example, wore out more rapidly when subjected to the desert heat and the brutally dry and rocky terrain of the Sinai. Moreover, Soviet tank radiators were too small for the demands of desert operations and thus prone to overheating. Andrew W. Marshall (Director of Net Assessment, Office of the Secretary of Defense) in discussions with author, April and August 2013.
- ²⁵ Pollack, *Arabs at War*, 568.
- ²⁶ Cordesman and Wagner, *Arab-Israeli Conflicts*, 102.
- ²⁷ Dupuy, *Elusive Victory*, 487n.
- ²⁸ Adan, *Banks of the Suez*, 22, 183, 190, 203.
- ²⁹ Michael J. Eisenstadt and Kenneth M. Pollack, “Armies of Snow and Armies of Sand: The Impact of Soviet Military Doctrine on Arab Militaries,” in *The Diffusion of Military Technology and Ideas*, eds. Emily O. Goldman and Leslie C. Eliason (Stanford, CA: Stanford University Press, 2003), 87–88.
- ³⁰ John A. Lynn, *Battle: A History of Combat and Culture from Ancient Greece to Modern America* (Boulder, CO: Westview Press, 2003), 313.
- ³¹ Pollack, *Arabs at War*, 568.
- ³² Norvell B. De Atkine, “Why Arabs Lose Wars,” *Middle East Quarterly* 6, no. 4 (December 1999): 23.
- ³³ Eisenstadt and Pollack, “Armies of Snow and Sand,” 87.
- ³⁴ De Atkine, “Why Arabs Lose Wars,” 23.
- ³⁵ Eisenstadt and Pollack, “Armies of Snow and Sand,” 87.
- ³⁶ De Atkine, “Why Arabs Lose Wars,” 23.
- ³⁷ The assessment of one prominent (and controversial) Arabist reinforces the view that cultural norms may impede maintenance performance. According to Raphael Patai, Arabs of an elevated social status hold an aversion to physical labor and consider it demeaning. Accepting this generalization, one might then extend it to explain poor Arab maintenance performance—at least partially. Shoddy maintenance practices and low equipment readiness rates in Arab armies could stem from officer disdain for wrench-turning and the consequential disinterest or lack of involvement in their units’ motor pool operations [Raphael Patai, *The Arab Mind*, rev. ed. (Tucson, AZ: Recovery Resources Press, 2007), 120–23]. That said, this connection is merely suggestive, and my analysis does not rely on Patai’s generalizations.
- ³⁸ O’Ballance, *No Victor, No Vanquished*, 16.
- ³⁹ Pollack, *Arabs at War*, 104.
- ⁴⁰ Mohamed Heikal, *The Road to Ramadan* (New York: Quadrangle, 1975), 43; O’Ballance, *No Victor, No Vanquished*, 16; Saad el Shazly, *The Crossing of the Suez* (San Francisco: American Mideast Research, 1980), 21.

- ⁴¹ O'Ballance, *No Victor, No Vanquished*, 15–16.
- ⁴² A. A. Grechko, *The Armed Forces of the Soviet State: A Soviet View—Soviet Military Thought*, no. 12, trans. under the auspices of the U.S. Air Force (Washington, DC: U.S. Government Printing Office, 1977), 221.
- ⁴³ Grechko, *Armed Forces of the Soviet State*, 222–24.
- ⁴⁴ Grechko, *Armed Forces of the Soviet State*, 101.
- ⁴⁵ Grechko, *Armed Forces of the Soviet State*, 224.
- ⁴⁶ Grechko, *Armed Forces of the Soviet State*, 101.
- ⁴⁷ P. A. Rotmistrov, “The Postwar Development of Tank Forces” in *Selected Soviet Military Writings, 1970–1975: A Soviet View—Soviet Military Thought*, no. 11, trans. under the auspices of the U.S. Air Force (Washington, DC: U.S. Government Printing Office, 1977), 279–80, 287; A. A. Sidorenko, *The Offensive: A Soviet View—Soviet Military Thought*, no. 1, trans. under the auspices of the U.S. Air Force (Washington, DC: U.S. Government Printing Office, 1975), 32–35; I. G. Zav'yalov, “The New Weapon and Military Art” in *Selected Soviet Military Writings, 1970–1975*, 211.
- ⁴⁸ Eisenstadt and Pollack, “Armies of Snow and Sand,” 69, 73; Grechko, *Armed Forces of the Soviet State*, 211–12; Zav'yalov, “New Weapon and Military Art,” 212. Soviet military organization supported this emphasis on the operational level of war. An army could have as many as 12 divisions under its direct control. In contrast, the U.S. equivalent to a Soviet army—the corps—usually consisted of two to four divisions.
- ⁴⁹ Fred Koch, *Russian Tanks and Armored Vehicles, 1946 to the Present: An Illustrated Reference* (Atglen, PA: Schiffer Military History, 1999), 32; John Milsom, *Russian Tanks, 1900–1970* (Harrisburg, PA: Stackpole Books, 1971), 80; Bryan Perrett, *Soviet Armor Since 1945* (London: Blandford Press, 1987), 26, 121, 131. T-54 and T-55 medium tanks, along with the similar T-62 model, comprised the bulk of the Egyptian military's tank forces in the 1973 conflict.
- ⁵⁰ Insight Team of the *London Sunday Times*, *The Yom Kippur War* (New York: Doubleday, 1974), 36, 38, 56; O'Ballance, *No Victor, No Vanquished*, 18.
- ⁵¹ Eisenstadt and Pollack, “Armies of Snow and Sand,” 66; Pollack, *Arabs at War*, 104; Insight Team, *Yom Kippur War*, 56.
- ⁵² Eisenstadt and Pollack, “Armies of Snow and Sand,” 68–72, 88–89.
- ⁵³ Heikal, *Road to Ramadan*, 179; Chaim Herzog, *The War of Atonement: The Inside Story of the Yom Kippur War* (Havertown, PA: Casemate, 2009), 21–22; Shazly, *Crossing of the Suez*, 101–102.
- ⁵⁴ Foy D. Kohler, Leon Gouré and Mose L. Harvey, *The Soviet Union and the October 1973 Middle East War: The Implications for Détente* (Coral Gables, FL: Center for Advanced International Studies, University of Miami, 1974), 34, 36; O'Ballance, *No Victor, No Vanquished*, 18–19; Pollack, *Arabs at War*, 106.
- ⁵⁵ George W. Gawrych, *The 1973 Arab-Israeli War: The Albatross of Decisive Victory* (Fort Leavenworth, KS: Combat Studies Institute, 1996), 19–20; Pollack, *Arabs at War*, 99–101; Shazly, *Crossing of the Suez*, 24–26, 29.
- ⁵⁶ Eisenstadt and Pollack, “Armies of Snow and Sand,” 77–78.
- ⁵⁷ Herzog, *War of Atonement*, 21–22.
- ⁵⁸ Herzog, *War of Atonement*, 34–35.
- ⁵⁹ Pollack, *Arabs at War*, 96, 104–105; Shazly, *Crossing of the Suez*, 20–21.

- ⁶⁰ O'Ballance, *No Victor, No Vanquished*, 26; Pollack, *Arabs at War*, 99, 105; Shazly, *Crossing of the Suez*, 47–48.
- ⁶¹ O'Ballance, *No Victor, No Vanquished*, 27; Shazly, *Crossing of the Suez*, 45.
- ⁶² Eisenstadt and Pollack, "Armies of Snow and Sand," 76.
- ⁶³ Kenneth L. Privratsky, "Comparing U.S. and Soviet Maintenance Practices," *Army Logistician* 18, no. 5 (September–October 1986): 7–8.
- ⁶⁴ Anthony H. Cordesman and Abraham R. Wagner, *The Afghan and Falklands Conflicts*, vol. 3, *The Lessons of Modern War* (Boulder, CO: Westview Press, 1990), 210–11.
- ⁶⁵ Heikal, *Road to Ramadan*, 179–80; O'Ballance, *No Victor, No Vanquished*, 19.
- ⁶⁶ Eisenstadt and Pollack, "Armies of Snow and Sand," 86.
- ⁶⁷ Eisenstadt and Pollack, "Armies of Snow and Sand," 79; O'Ballance, *No Victor, No Vanquished*, 73–74.
- ⁶⁸ Herzog, *War of Atonement*, 35.
- ⁶⁹ Pollack, *Arabs at War*, 100, 130; Eisenstadt and Pollack, "Armies of Snow and Sand," 79.
- ⁷⁰ Dupuy, *Elusive Victory*, 414–15; Shazly, *Crossing of the Suez*, 33–35, 64–65.
- ⁷¹ Robert M. Citino, *Blitzkrieg to Desert Storm: The Evolution of Operational Warfare* (Lawrence: University Press of Kansas, 2004), 176; Gawrych, *The 1973 Arab-Israeli War*, 27–28.
- ⁷² Shazly, *Crossing of the Suez*, 34.
- ⁷³ Shazly, *Crossing of the Suez*, 26.
- ⁷⁴ Dupuy, *Elusive Victory*, 420; Chaim Herzog, *The Arab-Israeli Wars* (New York: Random House, 1982), 248, 250.
- ⁷⁵ Gawrych, *The 1973 Arab-Israeli War*, 50–52.
- ⁷⁶ O'Ballance, *No Victor, No Vanquished*, 107–108.
- ⁷⁷ Cordesman, *Arab-Israeli Conflicts*, 57–60; Pollack, *Arabs at War*, 112–13.
- ⁷⁸ Shazly, *Crossing of the Suez*, 240.
- ⁷⁹ Dupuy, *Elusive Victory*, 547–48.
- ⁸⁰ Shazly, *Crossing of the Suez*, 25.
- ⁸¹ O'Ballance, *No Victor, No Vanquished*, 50–51.
- ⁸² Adan, *Banks of the Suez*, 81; Hassan el Badri, Taha el Magdoub and Mohammed Dia el Din Zohdy, *The Ramadan War, 1973* (New York: Hippocrene Books, 1978), 61–62.
- ⁸³ Adan, *Banks of the Suez*, 81; Gawrych, *The 1973 Arab-Israeli War*, 33; Pollack, *Arabs at War*, 112.
- ⁸⁴ Cordesman and Wagner, *Arab-Israeli Conflicts*, 90–91; Gawrych, *The 1973 Arab-Israeli War*, 52.
- ⁸⁵ Citino, *Blitzkrieg to Desert Storm*, 176; Dupuy, *Elusive Victory*, 414–15; Gawrych, *The 1973 Arab-Israeli War*, 38–39; Pollack, *Arabs at War*, 110; Shazly, *Crossing of the Suez*, 55–56.
- ⁸⁶ Cordesman and Wagner, *Arab-Israeli Conflicts*, 39.
- ⁸⁷ Herzog, *War of Atonement*, 156; O'Ballance, *No Victor, No Vanquished*, 83.
- ⁸⁸ Quoted in Gawrych, *The 1973 Arab-Israeli War*, 38–39.

- ⁸⁹ O'Ballance, *No Victor, No Vanquished*, 148.
- ⁹⁰ Pollack, *Arabs at War*, 129–30.
- ⁹¹ Pollack, *Arabs at War*, 56.
- ⁹² Shazly, *Crossing of the Suez*, 53.
- ⁹³ George W. Gawrych, "Combat Engineering: Egyptian Engineers in the Crossing Operation of 1973," in *Combined Arms in Battle Since 1939*, ed. Roger J. Spiller (Fort Leavenworth, KS: U.S. Army Command and General Staff College Press, 1992), 47–48.
- ⁹⁴ Shazly, *Crossing of the Suez*, 53.
- ⁹⁵ Shazly, *Crossing of the Suez*, 54.
- ⁹⁶ Eisenstadt and Pollack, "Armies of Snow and Sand," 89.
- ⁹⁷ Shazly, *Crossing of the Suez*, 52–53, 55–56.
- ⁹⁸ Cordesman and Wagner, *Arab-Israeli Conflicts*, 102–103. Egypt received about 300 tanks and 125 fighters from the Soviet Union during the war.
- ⁹⁹ Cordesman and Wagner, *Arab-Israeli Conflicts*, 102–103.
- ¹⁰⁰ Pollack, *Arabs at War*, 103–104.
- ¹⁰¹ Michael I. Handel, "The Yom Kippur War and the Inevitability of Surprise," *International Studies Quarterly* 21, no. 3 (September 1977): 496.
- ¹⁰² Badri et al., *Ramadan War*, 22; Herzog, *War of Atonement*, 32.
- ¹⁰³ Cordesman and Wagner, *Arab-Israeli Conflicts*, 102–103. In total, the Soviets dispatched some 500 tanks, 100 armored personnel carriers, 50 artillery pieces, 175 fighter planes and high quantities of munitions to the Arab belligerents. Much of this hardware had been earmarked for shipment prior to the war's commencement, with the first tranche coming by air and landing in Syria and Egypt on 9 and 10 October 1973 respectively [Arnon Gutfeld and Boaz Vanetik, "'A Situation That Had to Be Manipulated': The American Airlift to Israel during the Yom Kippur War," *Middle Eastern Studies* 52, no. 3 (2016): 428].
- ¹⁰⁴ Koch, *Russian Tanks*, 32.
- ¹⁰⁵ Citino, *Blitzkrieg to Desert Storm*, 179–80; Gawrych, *The 1973 Arab-Israeli War*, 55–56.
- ¹⁰⁶ Pollack, *Arabs at War*, 126.
- ¹⁰⁷ Citino, *Blitzkrieg to Desert Storm*, 182–83; Gawrych, *The 1973 Arab-Israeli War*, 56–57.
- ¹⁰⁸ Dupuy, *Elusive Victory*, 608.
- ¹⁰⁹ Dupuy, *Elusive Victory*, 401–403.
- ¹¹⁰ Cordesman and Wagner, *Arab-Israeli Conflicts*, 104.
- ¹¹¹ Martin van Creveld, *The Sword and the Olive: A Critical History of the Israeli Defense Force* (New York: Public Affairs, 1998), 241.
- ¹¹² Ashkar and al-Ayyubi, "Middle East Military Dimension," 19–20.
- ¹¹³ Cordesman and Wagner, *Arab-Israeli Conflicts*, 102.
- ¹¹⁴ Ashkar and al-Ayyubi, "Middle East Military Dimension," 4–5.

- ¹¹⁵ Adan, *Banks of the Suez*, 22.
- ¹¹⁶ Adan, *Banks of the Suez*, 183–84. Given the IDF’s emphasis on maintenance, it is perhaps no surprise that, of the 16 photographs included in Adan’s memoir, two depict soldiers actually performing maintenance (“repairing a tank in the dunes” and “replacing power plant of a tank in the field”).
- ¹¹⁷ Adan, *Banks of the Suez*, 190.
- ¹¹⁸ Cordesman and Wagner, *Arab-Israeli Conflicts*, 60.
- ¹¹⁹ Adan, *Banks of the Suez*, 203.
- ¹²⁰ Cordesman and Wagner, *Arab-Israeli Conflicts*, 61.
- ¹²¹ Dupuy, *Elusive Victory*, 609.
- ¹²² Pollack, *Arabs at War*, 125.
- ¹²³ Gutfeld and Vanetik, “American Airlift to Israel,” 420, 430–35.
- ¹²⁴ Cordesman and Wagner, *Arab-Israeli Conflicts*, 102.
- ¹²⁵ Gutfeld and Vanetik, “American Airlift to Israel,” 441; Arnon Gutfeld and Clinton R. Zumbrennen, “From Nickel Grass to Desert Storm: The Transformation of U.S. Intervention Capabilities in the Middle East,” *Middle Eastern Studies* 49, no. 4 (2013): 625–26.
- ¹²⁶ Lynn, *Battle*, 290.
- ¹²⁷ Zahlan, “Science and Technology Gap,” 29 (emphasis in original).
- ¹²⁸ Pollack, *Arabs at War*, 108.
- ¹²⁹ Cordesman and Wagner, *Arab-Israeli Conflicts*, 60.
- ¹³⁰ Williamson Murray arrives at a similar conclusion in *Military Adaptation in War: With Fear of Change* (New York: Cambridge University Press, 2011). On page 317, he argues, “What matters in technological innovation is how well new and improved technologies are incorporated into effective and intelligent concepts of fighting: it is not the technological sophistication that matters, it is the larger framework.”
- ¹³¹ Insight Team, *Yom Kippur War*, 185–87; O’Ballance, *No Victor, No Vanquished*, 280–82.
- ¹³² Pollack, *Arabs at War*, 125.
- ¹³³ Insight Team, *Yom Kippur War*, 189.
- ¹³⁴ Pollack, *Arabs at War*, 125.
- ¹³⁵ Pollack, *Arabs at War*, 125.
- ¹³⁶ Pollack, *Arabs at War*, 91–94, 96.
- ¹³⁷ Quoted in Eisenstadt and Pollack, “Armies of Snow and Sand,” 68.
- ¹³⁸ For an assessment of the courage of Egyptian soldiers, see Pollack, *Arabs at War*, 96–97.
- ¹³⁹ Herzog, *War of Atonement*, 35; O’Ballance, *No Victor, No Vanquished*, 74–75.
- ¹⁴⁰ Dupuy, *Elusive Victory*, 551–52.
- ¹⁴¹ Insight Team, *Yom Kippur War*, 189.
- ¹⁴² Insight Team, *Yom Kippur War*, 189.

- ¹⁴³ For a discussion of the connection between technical know-how and sound weapons employment—including the ability to improvise when necessary—see James J. Carafano, *GI Ingenuity: Improvisation, Technology, and Winning World War II* (Westport, CT: Praeger Security International, 2006), xvii, 30, 215–16.
- ¹⁴⁴ Murray, *Military Adaptation in War*, 296, 298, 303–304.
- ¹⁴⁵ Murray, *Military Adaptation in War*, 308.
- ¹⁴⁶ Murray, *Military Adaptation in War*, 303.
- ¹⁴⁷ Meir Finkel, *On Flexibility: Recovery from Technological and Doctrinal Surprise on the Battlefield* (Stanford, CA: Stanford University Press, 2011), 158–59, 163.
- ¹⁴⁸ Adan, *Banks of the Suez*, 3–5; Badri et al., *Ramadan War*, 22. Israeli Minister of Defense Moshe Dayan captured the prevailing view in an August 1973 lecture to army officers: “Our military superiority is the dual outcome of Arab weakness and our strength. Their weakness stems from factors that will not change soon . . . low level of their soldiers’ education, technology and integrity . . . disunion among the Arabs . . . and the decisive weight of extreme nationalism” (quoted in O’Ballance, *No Victor, No Vanquished*, 51).
- ¹⁴⁹ Pollack, *Arabs at War*, 102.
- ¹⁵⁰ Zahlan, “Science and Technology Gap,” 28.
- ¹⁵¹ Murray, *Military Adaptation in War*, 273–74.
- ¹⁵² Herzog, *War of Atonement*, 7–8, 148–49.
- ¹⁵³ O’Ballance, *No Victor, No Vanquished*, 83–84.
- ¹⁵⁴ O’Ballance, *No Victor, No Vanquished*, 19, 284.
- ¹⁵⁵ Dupuy, *Elusive Victory*, 472; Insight Team, *Yom Kippur War*, 188.
- ¹⁵⁶ Dupuy, *Elusive Victory*, 472; Insight Team, *Yom Kippur War*, 186–87; O’Ballance, *No Victor, No Vanquished*, 293–94.
- ¹⁵⁷ As it turned out, a joint effort by Israeli scientists and the military managed to piece together detailed information on the SAM-6’s guidance systems and radio frequency, but this discovery came too late in the war to be applied. Finkel, *On Flexibility*, 175.
- ¹⁵⁸ Zahlan, “Science and Technology Gap,” 24–26, 28–29.
- ¹⁵⁹ Murray, *Military Adaptation in War*, 296, 304.
- ¹⁶⁰ Adan, *Banks of the Suez*, 203.
- ¹⁶¹ Dupuy, *Elusive Victory*, 539.
- ¹⁶² Dupuy, *Elusive Victory*, 609.
- ¹⁶³ Finkel, *On Flexibility*, 175.
- ¹⁶⁴ DoD, *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense*, January 2012, 2.
- ¹⁶⁵ DoD, *Annual Report to Congress: Military and Security Developments Involving the People’s Republic of China 2018*, 16 May 2018, 24–41, 59–77.
- ¹⁶⁶ See, for example, The White House, *National Security Strategy of the United States of America*, December 2017, 2–3, 45–46; Michael R. Pence, “Remarks by Vice President Pence on the Administration’s Policy Toward China,” speech at the Hudson Institute, Washington, DC, 4 October

2018; and Kurt M. Campbell and Ely Ratner, “The China Reckoning: How Beijing Defied American Expectations,” *Foreign Affairs* 97, no. 2 (March–April 2018): 60–70. See also Kai Liao, “The Pentagon and the Pivot,” *Survival* 55, no. 3 (June–July 2013): 95, 108–109.

- ¹⁶⁷ Herbert Goldhamer, *The Soviet Soldier: Soviet Military Management at the Troop Level* (New York: Crane, Russak and Company, 1975), 21, 39–57.
- ¹⁶⁸ Goldhamer, *Soviet Soldier*, 61, 65–67.
- ¹⁶⁹ Goldhamer, *Soviet Soldier*, 96–99.
- ¹⁷⁰ Nathan Leites, *Soviet Style in War*, rev. ed. (Santa Monica, CA: RAND, 1992), 146–51.
- ¹⁷¹ Goldhamer, *Soviet Soldier*, 324.
- ¹⁷² Goldhamer, *Soviet Soldier*, 323–24.
- ¹⁷³ Privratsky, “U.S. and Soviet Maintenance Practices,” 7.
- ¹⁷⁴ Privratsky, “U.S. and Soviet Maintenance Practices,” 9.
- ¹⁷⁵ *Science of Military Strategy*, 288. For a snapshot of PLA logistical doctrine in the context of contemporary warfare, see *Science of Military Strategy*, 284–91. For a more readable and concise overview of ground force logistics, see Dennis J. Blasko, *The Chinese Army Today: Tradition and Transformation for the 21st Century*, 2nd ed. (New York: Routledge, 2012), 133–35.
- ¹⁷⁶ *Science of Military Strategy*, 280.
- ¹⁷⁷ Blasko, *Chinese Army Today*, 56–58, 224.
- ¹⁷⁸ Blasko, *Chinese Army Today*, 135; Puska, “Taming the Hydra,” 590–92.
- ¹⁷⁹ Abraham M. Denmark, “PLA Logistics, 2004–2011: Lessons Learned in the Field,” in *Learning by Doing: The PLA Trains at Home and Abroad*, eds. Roy Kamphausen, David Lai and Travis Tanner (Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 2012), 316–17.
- ¹⁸⁰ Puska, “Taming the Hydra,” 592.
- ¹⁸¹ Denmark, “PLA Logistics,” 326–27.
- ¹⁸² Denmark, “PLA Logistics,” 327.
- ¹⁸³ See, for example, the work of François Jullien, a French professor of Chinese philosophy. For a specific snapshot, see Jullien’s *The Propensity of Things: Toward a History of Efficacy in China*, trans. Janet Lloyd (New York: Zone Books, 1995), 259–65. Also see Richard E. Nisbett, *The Geography of Thought: How Asians and Westerners Think Differently . . . and Why* (New York: Free Press, 2003), xvii–xx.
- ¹⁸⁴ Blasko, *Chinese Army Today*, 126–27.



**Institute of Land Warfare
Association of the United States Army**

2425 Wilson Boulevard
Arlington, VA 22201

703.841.4300 ★ www.ausa.org