Air Power Promises and Modernization Trends after Operation Desert Storm

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Introduction

Today it is commonplace to hear that the progress of air power has either revolutionized warfare or, at a minimum, revolutionized the relationship between air and ground forces in warfare.[1] Drawing on air power theorist Colonel John Warden, Richard P Hallion sees in the experience of the Gulf War the advent of a post-Clausewitz-ian era in which air power can serve to leapfrog the fielded military forces of an adversary to attack directly and decisively the strategic "inner rings" of national power.[2] Inspired by the prospect, some United States Air Force analysts are busy reworking the classic principles of war and advocating a revolution in how we think and even speak about war.[3] USAF commanders are more circumspect. Indeed, Lt General Charles Horner, Joint Force Air Component Commander for Operation Desert Storm (ODS), asserts that he does not know what is meant by references to an “air power revolution.”[4]

In the context of independent military services vying for shares of diminishing defense budgets, talk of a "revolution in warfare" has clear bureaucratic-political implications. In politics, as in poker, it is unwise to crow about a winning hand until the hand is played and the pot won. General Horner's modestly notwithstanding, the USAF firmly believes that it holds a winning hand. In *Global Reach, Global Power* former Secretary of the Air Force Donald Rice asserts that "air power technology caught up with air power theory in Southwest Asia" allowing air forces to achieve "a degree of effectiveness that earlier air power pioneers foresaw, but which the technology of their day could not yet deliver."[5] Of course, to air power enthusiasts, the historical promise of air power is to deter and, more importantly, win wars – quickly, decisively, more or less independently, and in a uniquely cost-effective fashion. Although USAF leaders demure from the final, controversial step in this argument, it fairly asserts itself.

In his summary to the *Gulf War Air Power Survey* (*GWAPS*), Eliot Cohen approaches the issue of an air power revolution cautiously, asserting that "it is probably too soon" to declare "without reservation that we have entered a new era of warfare." Nonetheless, he concludes that in the Gulf conflict air power did cross "some operational thresholds which...suggest a transformation of war."[6] However, as Cohen astutely notes, there is considerable distance between the new operational effects observed in ODS and a true military revolution – which at minimum requires the maturation of new technologies, their integration into new systems, the adoption of appropriate operational concepts, and the development of suitable organizational forms.[7]

Following Cohen's lead we can usefully distinguish among (1) the effects observed in a specific war resulting from the application of new technologies, (2) a universal change in the dynamics of warfare, affecting the basic calculus of what can and cannot be accomplished in war, and (3) a fundamental revision in how we think about, plan, organize, and provision for war. Cohen argues that what we saw in the Persian Gulf strongly suggests (if not "promises") that a fundamental change in warfare can be achieved given continued investment in certain pivotal technologies as well as appropriate changes in organization and operational concepts. (In other words, he believes that #1 probably entails #2, but if and only if #3.) Cohen concludes the survey by saying that "if a revolution is to occur, someone must make it."[8] This puts the real work ahead of us, not behind.

Current modernization trends in the United States clearly reflect enthusiasm for the promise of air power, emphasizing those technology areas thought to be key to an air power revolution: stealth platforms, precision-guided munitions, standoff weapons, and C3I/reconnaissance, surveillance, and target acquisition systems. As noted above, doctrinal and organizational developments within the Air Force are proceeding apace. Of course, the revision of roles and missions across services and the development of new joint doctrine is more sticky. Nonetheless, the Pentagon's *Bottom Up Review* of US defense requirements leans heavily on the promise of air power when prescribing how the United States can fight two major regional conflicts concurrently with a force structure approximately one-third smaller than that available in 1990.[9]

Can air power deliver on its putative promise – and if so, at what cost? For the purposes of the current discussion on force modernization and restructuring this question resolves into several parts. First, what new capabilities can the core technologies reasonably promise? Second, what is the likely operational and strategic significance of these promised capabilities, assuming that they attain. Third, what costs – including opportunity costs – are associated with gearing defense investment, force restructuring, and operational planning toward the promise of air power? A thorough examination of the costs and significance of new air power capabilities should also take into account likely counter-moves by adversaries and stability effects.

A vital background issue for our inquiry is the extent to which the experience of the Gulf War derived from a strategic revolution, not a military one – namely, the demise of the cold war global system. The Gulf War was notably a contest between combatants with vastly different technological and economic potentials. For decades the cold war had in various ways tended to

level such differentials. The end of the cold war allows these differentials to come to the fore, and they nowhere appear more pronounced than in the area of air power. There is a growing gap between those few states that can deploy advanced technology on capable air platforms and the vast majority of states which can at best muster only a desperate response. In this light, one could conclude, against the counsel of air power proponents, that no heroic modernization or restructuring efforts are required in the near-term to maintain the qualitative gap between northern and southern powers.

The Promise(s) of Air Power

The idea that aircraft dropping munitions can pose a threat which deters, compels, or defeats an opponent while largely avoiding the horrors and costs of ground warfare is a compelling one – not only among military and air force leaders, but among political leaders and the broad public as well. Recent advances in technology, especially as applied to air forces, have greatly augmented the capacity to deliver firepower with precision over great distances. Suggestive of the change is a comparison across decades of the requirements for hitting a 6000 sq ft target with a 2000-lb bomb: during WWII, 9000 bombs in 1500 B-17 sorties; during the Vietnam war, 176 bombs in 44 F-4 sorties; during the Gulf War, 30 unguided bombs in eight sorties or one laser-guided bomb in a single sortie.[10]

Although procurement costs for air power systems have risen sharply, when measured against performance criteria these systems have probably grown more economical, not less.[11] This trend is reinforced, especially for recent years, if we include in the calculation of cost such factors as mission capable rates, aircraft attrition, crew lives lost, and the likely extent of collateral damage inflicted in attack missions. Also contributing to the apparent promise of air power is the change in the capabilities of likely adversaries – namely, nations of the south. As noted earlier, these nations are particularly vulnerable to air power. Hence, from the perspective of advanced technological states, air power seems to be not only an increasingly economical tool of strategic policy but also an increasingly competitive one.

The real utility of air power to political leaders, however, resides in the military options it provides. This also decides the real significance of any "revolution" in technical and tactical capabilities or any "phase shift" in cost-effectiveness. Nuclear weapons are a case in point: they provide a uniquely inexpensive means for delivering enormous firepower at great distances. Moreover, access to these weapons has been and remains limited. However, these facts alone tell us little about the practicable options that the nuclear revolution puts at the disposal of political leaders, which have turned out to be much more limited for operational and strategic reasons than many thought at the dawn of the nuclear age.

Translating the claim of an air power revolution into operational and strategic terms, we find it resolves into three distinct but related promises or claims.

- The air power revolution has expanded the option for limited-aims "raiding missions," especially against adversaries with lesser capabilities. This is true whether such raiding is intended for material destruction (e.g. of nuclear facilities or military-industrial sites) or for psychological intimidation (to halt, inspire, or deter some action or behavior). In several senses, such raids can now be conducted with more "discretion" than ever before: surprise is more reliably achieved, ingress and egress is less risky, interdiction is more precise. This might be termed the precision raiding promise.

- The air power revolution makes it easier than ever before to circumvent the costliest aspects of full-scale or major conventional war via a strategic bombardment campaign, which can achieve a general and decisive defeat with minimal casualty and cost. This might be termed the strategic air campaign promise.

- The air power revolution makes it possible to completely dominate the ground forces of an opponent from the air, thus obviating the engagement of ground forces. This can be achieved both through the above-mentioned strategic campaign and through the added element of precise and effective ground force attrition (via battlefield interdiction and close air support). This might be termed the ground battle dominance promise.

These "promises" underlie perceptions about the future of warfare and of air power following the Gulf War and into the next decades, and are the focus for closer examination here. In the following sections we will first assess the extent to which current technological trends support these promises and then examine the promises themselves in terms of non-technical (operational and strategic) limits and trade-offs.

The Technologies and Systems

Improvements in "stealth" technologies – such as airframe design, composite radar-absorbing materials, and non-emitting avionics systems – have combined with advances in electronic counter-measures (ECM) systems to permit the surprise, evasion, and early defeat of enemy air defenses. Greater accuracy in the targeting and delivery of munitions has improved capabilities to suppress enemy air defenses (SEAD) by effective attacks on radar, artillery, and surface-to-air missile (SAM) facilities. Low-level airborne penetration techniques and weaponry which can be delivered outside the range of air defenses ("standoff" weaponry) contribute to the evasion of such threats altogether.

"Stealth" has become a general preoccupation of aerospace designers, such that stealthy design features are being adapted and applied to a wide variety of platforms and weapons. Along with this relatively passive means of defeating air defenses, US modernization plans include further development of active options to defeat opposing air defenses. These include anti-radiation weapons, building on the existing High-Speed Anti-Radiation Missile (HARM) system, and the Tri-Service Standoff Attack Missile (TSSAM) for long-range attack on high altitude systems. Development concepts include non-emitting systems detection, the silent

hard-kill (SHARK) concept, and a possible high-energy laser system to be used in conjunction with LANTIRN systems on F-15s and F-16s.[12]

Recent advances in computation and signal transmission speeds have supported a quantum leap in navigation, command and control, communications, and reconnaissance, surveillance, and target acquisition. Key integrative systems here are the Airborne Warning and Control System (AWACS), the Joint Surveillance Target Attack Radar System (JSTARS), and the Global Positioning System (GPS).

The USAF has plans to equip all in-service aircraft with GPS receivers by 2000, giving its aircraft an unprecedented capacity to process three-dimensional position, velocity and time data.[13] Perhaps more significantly, "smart" weaponry may also benefit from GPS receivers, improving accuracy with potentially lower costs.[14]

Generally, and specifically in the AWACS and JSTARS systems, we can see efforts to centralize intelligence-gathering with command and control assets. At the same time, as with the wide emplacement of GPS receivers, we are seeing efforts to distribute initially raw and eventually processed intelligence to a greater range of users and weapons platforms. Airborne and space-based reconnaissance assets, battlefield surveillance and damage-assessment capabilities, and other forms of intelligence data are quickly becoming part of the same network as command and control and target acquisition systems, using data links which aspire to real-time communications. Modernization of precision weaponry aims to incorporate these developments with delivery systems that are not simply "smart" (using the products of satellite links and laser designators to acquire and reach their target but still with a human in the chain), but "brilliant" (capable of integrating information on their own and reaching their targets autonomously).

Examples of systems that seek to synthesize target detection with guidance and delivery include the Joint Direct Attack Munition (JDAM) and the Northrop/Hughes GPS-Aided Targeting System/GPS-Aided Munition (GATS/GAM).[15] Such systems represent a drive to free precision-guided weapons from dependence on terminal command (via video data links or laser designation), terrain contour mapping (requiring detailed three-dimensional maps and immense computer memory), and inertial guidance. The overall trend is towards target acquisition systems that directly link with GPS, and toward autonomous delivery systems such as Brilliant Anti-armor submunitions (BATs) and sensor-fused weapons (SFWs). These latter systems represent part of a broad effort to develop weapons that can precisely attack and thus impose high attrition on enemy armor and artillery concentrations.

Specific Limitations

Stealth airframe design involves enormous financial costs, in addition to important trade-offs in flight capabilities. The F-117 program unit cost was $111.2 million (unit fly-away cost was $42.6 million). Program unit cost for the B-2 "Stealth" bomber is about 2.2 billion with important

technical difficulties still plaguing the program. Proponents argue that such weaponry dramatically reduces the overall effort required in any given attack, with the defense evasion, suppression and accurate munitions delivery capabilities obviating the need for complementary escort aircraft.[16] However, comparisons of stealth and non-stealth mission packages meant to illustrate this point often exhibit a very idiomatic logic.

One such presentation by Lt. General Horner to the Defense Appropriations Subcommittee of the US House of Representatives compared a daylight attack with non-precision weapons by F-16s against an Iraqi nuclear facility to a night attack by F-117s with precision weapons against the same target.[17] The F-16 package, which failed in its mission, comprised 75 combat and support aircraft. The stealth package, which succeeded, comprised 10 combat and support aircraft. Horner estimated the procurement and 20-year operational costs for the larger package to be $6.5 billion; for the stealth package, $1.5 billion.

There are four problems with Horner's comparison: first, it is not about "stealth" alone but also precision-attack and night-fighting capabilities; second, it fails to take into account the full-range of capabilities included in the larger package – the 16 fighter escorts, for instance, provide the air force with a vital air-to-air capability that the F-117 does not; third, the comparison fails to include EF-111A Raven and EA-6B Prowler aircraft in the "stealth" package, although we now know that the F-117 depended on these aircraft to "enhance its stealth effects;" and finally, the comparison ignores the fact that all aircraft gain some "virtual stealth" capability once enemy air defenses have been suppressed. In sum, the comparison does not provide much support for having more than a small number of advanced stealth platforms in an air fleet.

As suggested above, investment in stealth aircraft involves operational trade-offs that should not be overlooked. More stealth may mean less capability in other dimensions of an aircraft's role. Commenting on the trade-off, a senior manager of the European Fighter Aircraft (EFA) program declared that the US F-117 "Stealth" fighter could not match EFA's supersonic capabilities and agility because of it's design deficiencies.[18] Ultimately, any decision to ignore or accept the trade-off of maneuverability for stealth undermines defensive counter-air (DCA) capability, thus forcing greater reliance on offensive counter-air (OCA) and, in turn, SEAD. That is, a decision to prioritize stealth over agility is in fact a direct decision in favor of offensive, penetrative capabilities – which create yet more demand for stealth.

Stealth aircraft designs require an enormous up-front development investment. And yet, the advance they embody is very "brittle" – that is, not amenable to an easy fix should successful counter-measures be forthcoming. Moreover, stealth's operational value makes it an advance that invites dedicated efforts to undermine it by altering the means of detection. New low-frequency and multi-static radars now in service or development can reputedly already detect the B-2 and possibly the F-117 at certain frequencies.[19] Responding to criticism that the B-2 failed low-observability tests in July 1991, Air Combat Command Chief Mike Loh testified to the House Armed Services Committee that though the aircraft would be improved, it would not "meet its specification at every frequency, at every angle, at every elevation," thus

accepting the vulnerability of the bomber to detection.[20] Other sensors, such as electro-optical and acoustic, could also improve to effectively track "stealth" designs.

For an aircraft to remain invisible to enemy sensors it must also limit its use of target-acquisition and navigation radars, each of which gives off detectable signals. Development of technologies to provide these capabilities with passive (or non-emitting) systems is unlikely to outpace development of stealth countermeasures (such as the detection systems mentioned above) for long if at all. All these factors indicate that "stealthy" platforms may reach drastically diminished penetrative capacity, turning weapons like the B-2 and F-117 into very expensive stand-off platforms – a role in which many older and less costly systems can equally perform.

GPS-derived targeting systems are not without serious operational limitations. The "GPS-bias" refers to a difference between the real location of a target, and the location perceived by the GPS system, which can add as much as 45 feet to the inaccuracy of a precision weapon which already expects some degree of inaccuracy. Neither terrain-mapping nor GPS-assisted weapon delivery can yet match the effectiveness of laser-guidance, meaning that such systems do not yet provide the kind of capabilities required either by the precision raiding or the ground-battle dominance promises. Other, somewhat separate problems with GPS include the potential vulnerability of the system and its various internal links and connections with control and delivery systems to jamming. The electronics community has expressed concerns over the vulnerability of GPS systems to intentional and unintentional jamming, such that the USAF is now soliciting proposals for various systems designs to address the problem.[21] (A separate issue concerns the proliferation of GPS receivers among military and commercial users and the corresponding decrease in unit costs portends an increase worldwide of the capacity for precision targeting.[22])

JSTARS and AWACS systems performed well in the Gulf War. But the ongoing effort to further centralize C3I courts unrecognized risks. Increasing the focus on a few very expensive "key node" platforms invites operational countermeasures – that is, dedicated attack. Success against even a few JSTARS and AWACS platforms could be devastating. The loss of several such "nodes" could severely hamper either a general strategic campaign, and even the destruction of one could either undermine the precision raid or at a minimum, diminish the ground attrition campaign.

Broader Issues

Precision Raiding

Behind the promises of air power lies an assumption that the air power "revolution," writ large or small, has altered the balance among risk, capability, and gain in war. By making warfare less risky in terms of our lives and our pockets (finances), we can afford to pursue goals by means of war that we might have previously dismissed as either unachievable or, if achievable, too costly. Given the capability are we now to seek low-gain, relatively or previously unimportant

goals? Although this question pertains to all three air power promises, it is most relevant to the prospects for precision raiding.

As we saw with the Gulf War incident at the Amariyah shelter, civilian casualties are virtually inevitable with even the most precise bombardment. As Lt. General Buster Glosson, who directed joint air planning during the Gulf War, is fond of saying: air power is targeting, and targeting is intelligence.[23] One implication of this, however, is that not even a zero circular error probable (CEP) can guarantee that the chosen target is what it is supposed to be and nothing else at the moment of attack. In other words, there is difference between accuracy and intelligence. And, of course, no one is talking about consistently achieving zero CEP.

There are other ways for error to creep into the targeting-destruction cycle as well, sometimes with devastating effect. The *Gulf War Air Power Survey* (*GWAPS*) makes note of "the gap that inevitably exists between specifying a target such as a petroleum refinery and picking the particular aim-points to be hit there."[24] This observation refers to the failure of pilots in the Gulf War to adhere to the informal policy of minimizing long-term damage when attacking electric power and oil refining facilities (which we examine in more detail below). Among the unintended and unforeseen consequences of this failure may have been the death of tens of thousands of Iraqi civilians. After the war, a team of investigators from the Harvard School of Public Health estimated 70,000-90,000 postwar civilian deaths principally due to the lack of electricity for water purification and sewage treatment.[25]

The political risks and moral cost of such horrors remain high. Significantly, the same "information revolution" that undergirds the putative promise of air power will ensure that every horror of war is broadcast. Yesterday there was only a photojournalist with a camera, tomorrow there will be a proliferation of citizens with telecams and satellite uplinks.[26] Even given a rapidly rising standard of what constitutes acceptable "collateral damage" citizens will probably continue to support military action as a last resort to protect truly vital interests. Military action to achieve ends that are less or far less than vital is another matter.

There are few and fewer technical obstacles to the US expanding its practice of precision raiding. With the end of the Cold War, there may also be far fewer geopolitical obstacles. However, in addition to the concern outlined above, such action will confront the more complex difficulties associated with compellence or coercion as a strategy.[27] Compellence or coercion depends quite strictly on both sides sharing an understanding of what a war is about, and what types and degrees of loss are acceptable. Military methods must be tailored to match diplomatic objectives in a way that takes fully into account differences between the contending parties in interests, degree of interest, and how each party perceives these. Otherwise, we may discover to our dismay that what has become technically easy to do has less than desired or even counter-productive strategic effects.

As the US learned painfully in Vietnam, differences among contestants in perception or sentiment can be a recipe for disaster. Potential adversaries may have more invested in continuing their behavior or resisting the demands of an outside power than that power can

leverage through bombing. The two sides may simply put different values on the assets at risk – especially if one side has a popular form of government and the other does not. There is, of course, the option of turning up the heat. What limits this option is not sufficiency – that is, whatever it takes to succeed – but rather proportionality as judged by the world community and domestic opinion. At any rate, at some point "turning up the heat" violates the activity's definition as a low-cost limited action.

Strategic Power

The United States proved in the Gulf War that it could quickly gain complete mastery of the skies over all Iraq and deliver munitions wherever it pleased with near impunity. Nonetheless, analysis of the war suggests that the operational significance of a comprehensive strategic campaign in a short war against a much weaker adversary may be quite small. Of course, the financial costs of such a massive effort are high; the opportunity costs of expending resources in that effort rather than in a direct effort at materially diminishing an opponent's fielded military can also be high.

In assessing what it calls the core strategic campaign the *Gulf War Air Power Survey* makes a distinction between "the delivery of weapons on aim-points and operational-strategic significance."[28] The core campaign included leadership (L), command-control-communications (CCC), nuclear-biological-chemical (NBC), ballistic missile (SCUD), and electricity and oil targets (E&O). The survey found it hard to estimate the significance of attacks on L and CCC targets; they were certainly very disruptive, but clearly fell short of destabilizing the regime or cutting all communications with its fielded military. The effect of attacks on NBC targets were judged to have little immediate military significance. After the war UN inspectors found the regime in possession of 150,000 intact chemical munitions and a nuclear program that was, in the words of an American IAEA inspector, merely inconvenienced.[29]

Although the hunt for mobile SCUDs significantly suppressed launch rates, it failed to remove the immediate threat. Indeed, the survey finds no indisputable evidence for even a single kill, instead inferring from the level of effort that a "few may have been destroyed." Its conclusion: "Coalition air power does not appear to have been very effective militarily against this target category."[30] By contrast, attacks on production, storage, and fixed launch sites were found to have achieved the objective of removing the post-war Iraqi threat to its neighbors.

Air attacks proved very effective in reducing Iraqi electricity generation and oil refining capacity – by 88 percent in the first case, 90 percent in the second. Yet, here too the survey found no immediate military significance.[31] As noted earlier, the mid-term effect on civilians, by contrast, may have been profound due to lack of electricity for water purification and sewage treatment. Although campaign planners had been careful to specify aim points that minimized long-term damage, pilots did not follow this direction. The *GWAPS* suggests that this discrepancy resulted in part from the decision to go after most of Iraq's 25 major power stations beginning in the first hectic week of the war, which overloaded the pilots. But this type of crunch is not exceptional; it is the necessary concomitant of an approach that emphasizes massive,

deep, and simultaneous attack on a broad range of targets, many of which are heavily defended.

The operational trade-offs that a comprehensive strategic campaign imposes are also significant. In the Gulf War, missions directed at the deep Iraqi military and industrial infrastructure were conducted at the direct expense of a focused effort on eliminating the Iraqi SCUD missile threat early, and at the expense of an earlier, more concentrated, and more thorough debilitation of Iraqi ground forces – especially Republican Guard units. The *GWAPS* concludes that "the diversion of air assets to the 'great Scud chase' was not large relative to [the number of] strikes recorded during the war."[32] In all fairness, most of these strikes were delivered against ground forces – but not enough to bring average Republican Guard combat capability below 75 percent before the onset of the ground war. Many Guard units retained enough strength and cohesion to fight and to retreat. Their escape from Kuwait constitutes the most significant failure of the Coalition effort – a failure that sealed the fate of the post-war rebellions within Iraq and gave the Hussein regime a new lease on life.

Perhaps 10-15 percent of the air effort in the Gulf War went to the strategic campaign, including attacks on mobile SCUDs (about 3-5 percent) and theater logistics interdiction. Although this does not suggest much room for redistribution, the percentages mask the true cost of the strategic campaign, which must include a disproportionate share of the counter-air and SEAD effort. Slicing the actual air effort a different way we find that about 10 percent went to the "core" strategic campaign, 8 to SEAD and Offensive-counter Air, 18 percent to defensive counter-air, 4 percent to the SCUD hunt, and about 60 percent to attacks on ground forces and interdiction of their supplies (of which 8 percent were directed against the Republican Guard).[33] Redistribution of some of the core strategic and SEAD/OCA could have allowed a significantly greater effort against SCUDs and the Republican Guard segment of ground forces. The aircraft shelter busting campaign and attacks on O&E targets alone required an effort 25 percent as great as the SCUD hunt and anti-Republican Guard effort.

In light of the costs and benefits of the effort against strategic O&E targets summarized above, the prospect of diverting such efforts should not be controversial. De-emphasizing the shelter busting campaign (or OCA generally) is more so, but it should not be. As Col. John Warden has pointed out,

> "If equipment, doctrine, or will suggest that the enemy will never use, or effectively use, his air forces, then it would be pointless to expend great effort to destroy them merely because of one's own doctrine. In this case the air arm could immediately find use in some form of interdiction or close air support." [34]

Air power orthodoxy may also impose negative operational tradeoffs by means other than the distribution of strikes and sorties. After reviewing the remarkably rapid and comprehensive neutralization of the Iraqi air force and air defense system, the *GWAPS* notes that it did find even a roughly comparable level of sophistication in the campaign against the Iraqi ground

forces in Kuwait: "This asymmetry seems to have arisen as much from the historical preferences of Coalition operators as from the weaknesses in Coalition intelligence."[35]

Apart from the issue of operational trade-offs there are other reasons to question the wisdom of comprehensive attacks against leadership and CCC targets, even though such attacks certainly degrade military capability. Any sensible military command structure will have contingency plans to delegate authority further down the command chain in the event of a CCC breakdown. At a minimum, this closes the avenues through which diplomatic progress on the national level can rapidly influence events at the battlefront. More serious, in a conflict where the combatants deploy NBC weapons, a breakdown in CCC increases the chances of their use.

Similarly, the general attack on strategic assets serves to weaken any intra-war deterrence. Restraints on expanded military action or acts of NBC or environmental terrorism are diminished as remaining sanctuaries from attack are violated. The broad opening gambit in the Gulf War, which brought Baghdad and other major Iraqi cities under attack, left the Iraqi leadership with little reason to exercise restraint, and in fact may have invited their own effort at strategic retaliation – ruining the fruits of Kuwaiti liberation by setting oil fields ablaze. Avoiding such attacks might have left Iraq with adequate reason not to dump Kuwaiti oil or set oil wells on fire.

Ground Battle Dominance

The *GWAPS* confirmed CENTCOM's estimate of the proportions of Iraqi army equipment destroyed by air power prior to the ground war – 39% of tanks, 32% of armored personnel carriers, and 47% of artillery.[36] Air interdiction also succeeded in reducing the flow of supplies into the theater by 90%, destroying many of the large stockpiles already located in the theater, and completely disrupting intra-theater logistics. As a result of these successes and, more directly, the unrelenting bombardment of troop concentrations, air power completely dispirited the Iraqi field army.[37] At the cost of less than a single squadron of Coalition aircraft lost, the ODS battlefield attack and interdiction campaign achieved air-ground exchange ratios that were not only unprecedented, but were more than an order of magnitude greater than those seen in any other conflict except the 1982 war in Lebanon.

More revealing than the raw facts of the air-ground war, however, is an analysis of some of the longer-term developments in air power that produced these facts. Of particular relevance to the air-ground operations are the improvement and proliferation of (1) all-weather, night-fighting capabilities, (2) precision-guided munitions and their delivery systems, (3) electronic warfare and other counters to guided air defense weapons, and (4) integrative, comprehensive airborne ground surveillance systems. In the first three cases we have already seen the maturation of new technologies, a gradual shift toward their employment in mass, and an associated change in operational concepts and training.

These developments do not mean, however, that the gross effects observed in the Gulf War would be replicated in conflicts among advanced industrial states. Nor do they mean that

large-scale conventional wars among less industrial states will show the same effects. Finally, these developments do not mean that ground forces are without adaptive options. Such options include much greater investment in electronic warfare and air defense, adoption of stealthier designs for ground systems, and new operational concepts and organizational forms. Ground units will disperse more and become lighter, more mobile, and less numerous. They will put greater emphasis on longer-range fires. Ground operations may, at least initially, focus more on SEAD, counter-battery fire, attacks on C3I, and deep disruptive raids.

Advanced industrial armies will be able to take the adaptive steps outlined above. These steps would indeed revolutionize ground forces and their relationship to air forces. However, with or without such a revolution, we should not expect to see in wars among advanced industrial states the types of effects observed in the Gulf War -- that is, easy low-cost destruction of ground forces.

The armies of less industrial states will have a much harder time adapting. Lacking a superpower sponsor, the transition to smaller, more mobile, more technology-intensive, and better-trained armies assumes a fundamental change in socioeconomic conditions. [38] Moreover such an effort makes little sense vis-a-vis local conflicts without a corresponding and much greater investment in air power.

The implication of this analysis is that the "ground battle dominance" promise of air power holds and will continue to hold for contests between advanced industrial states and poorer states. Moreover, this promise does not hinge on a continued high-pace of new system development and procurement in the North, at least through the mid-term – say, 2010. From the perspective of Western security concerns, the most important and practicable part of this promise is a capacity to rapidly deploy a defensive air shield against aggression in distant theaters.

With regard to contests among advanced industrial powers, the prospects for ground force dominance are far less promising. Although a "revolution" in how we organize, manage, and provision joint air-land operations may be needed to ensure that no advantage accrues to a peer competitor, there is at present no such competitor in sight. For the time being, the requirements arising from the first type of contest (North vs South), which are minimal, should set the pace of modernization. The wisest way to presently address the longer-term possibility of a new peer competitor is through organizational change, operational adaptation, and R&D investment.

In several respects current modernization programs depart widely from the real requirements of deterring and defending against today's ground force threats. Technologies promising large-scale standoff precision attack on ground forces reflect visions of war against the deeply-echeloned, numerically-superior, and technologically capable armies of the former Warsaw Pact. In conflicts like the Gulf War, the adversary is far less challenging. Although standoff attack on adversary ground forces will reduce the rate of aircraft attrition, this is already remarkably low. Reducing it further by adopting standoff range comes at the expense of precision – that is, effectiveness. Of course, standoff weapons can be made more precise, but

only at great cost. At any rate, most of the air loses during the Gulf War occurred during either strategic attacks on heavily defended targets or low level attacks. Medium altitude attacks on ground forces were not very costly.

Interestingly, in the Gulf War, precision proved less necessary in meeting the most worrisome contingency: an early Iraqi ground attack into Saudi Arabia. When Iraqi ground forces marshaled for an attack through Al-Khafji (with several battalions in the lead and elements of three divisions waiting behind) the coalition air response was overwhelming, relying heavily on general purpose bombs and cluster munitions. In this short battle, coalition air power claimed more Iraqi equipment than in any comparable period of the air war.[39] This is because mechanized offensives require concentration and exposure. Significantly, the cost in lost aircraft was very low – one loitering AC-130 downed. Air defense is difficult when on the move. GPS-guided standoff weapons might improve on the record established during Al Khafji if they receive accurate and rapidly-updated coordinates – but the improvement would be only marginal.

Finally, plans to field large numbers of advanced aircraft equipped with long-range precision weapons (TSSAM) makes especially little sense for contests like the Gulf War. If standoff attack on enemy ground forces is to become the norm, then it should mostly originate from less expensive air or ground force platforms. Generally, the impulse to invest in platforms with stealth and other penetrative capabilities has more to do with enabling strategic campaigns than ensuring dominance over the ground battle. In this way and others, as noted in the previous section, the "strategic campaign" promise can act as an impediment to achieving "ground battle dominance."

Conclusion

The events of the past few years have provided the West with a security windfall. Although the coming era confronts us with instability and uncertainty, no one would trade our present situation for the cold war, when competition with a peer adversary stretched from the heartland of Europe into every corner of the globe. During the cold war, military investment and development was driven hard by necessity and a perception of threat to our most fundamental interests. Today, by comparison, we contemplate military modernization from a position of relative freedom and power. There is today a temptation to adopt aims and methods that seemed impracticable during the cold war period. But the rising curve of technical, tactical, and operational capability does not describe what is wise strategically. What can be done or might be done cannot decide what should be done. Instead, our choice of modernization paths and goals must be guided by an appreciation of the real and likely threats to our truly vital interests. Uncertainty regarding the deep future will remain, but this is best addressed by reconstitution strategies, investment in research and development, and general efforts at economic revitalization.

The preservation of Western strength depends, in part, on Western restraint in the selection of strategic aims and military methods. This is because our present strength is partly relative in nature – relative, that is, to the absence of an adversarial alliance. So it is important to recognize that a process of global re-polarization could occur in the next 10-20 years, initially reflecting existing fault lines in the world system but eventually entailing entirely new alignments. Such a development would foreclose many of the opportunities opened by the end of the cold war. Although it is not in our power to flatly prevent such a development, the misuse of our power would certainly help precipitate it. The standard of proper restraint in this case is defined by our real needs and by global standards of fairness, proportionately, and minimum necessary application of force.

A more immediate and practical issue that exhibits the same logic concerns the proliferation of weapons of mass destruction. The Gulf War taught us that our capacity to accurately gage and then compromise NBC capabilities is limited. Today, the republics of the former-Soviet Union hold their considerable NBC capabilities in a sieve that is leaking all over the world. Under the best of circumstances, controlling proliferation would be difficult. It would be impossible in a world where smaller states believe that the possession of such capabilities provides the only sure guarantee of equality and fair play. Of course, the leaders of some nations are incorrigible – nothing will convince them. But this is not true of most nations.

Restraint is a necessary component of strategic wisdom. Although the question of how to use power is not the same as the question of what capabilities to seek, the fact of scarce resources requires us to constantly cross-reference them. In choosing among different possible paths of military development we must remain mindful of the distinctions between what can be done, what must be done, and what might inadvertently help bring about those outcomes that worry us the most.

Notes

1. See Richard P. Hallion, *Storm Over Iraq* (Washington: Smithsonian Institution Press, 1992) for a thorough and passionate presentation of the "revolutionary" view.

2. Hallion, *Storm,* pp 16-17, 150-154.

3. See, for example, Col Phillip Meilinger USAF, "Towards a New Airpower Lexicon," *Airpower Journal* (Summer 1993) and Lt Col Price Bingham USAF (retired), "The United States Needs to Exploit Its Air Power Advantage," *Airpower Journal* (Fall 1993).

4. General Charles Horner, USAF, "Offensive Air Operations: Lessons for the Future," *RUSI Journal* (Dec 1993) pp. 19-24.

5. Donald Rice, *Global Reach, Global Power* (Washington DC: Department of the Air Force, December 1992), p 11.

6. Eliot Cohen, *Summary to the Gulf War Air Power Survey* (Draft) (Washington DC: Government Printing Office, Ap 1993), Chap 10, pages 9 and 18.

7. Cohen, *GWAPS Summary* (Draft), Chap 10, p. 4.

8. Cohen, *GWAPS Summary* (Draft), Chap 10, p. 18.

9. Les Aspin, *Report on the Bottom Up Review* (Washington DC: Department of Defense, Oct 1993); also see, Christopher Bowie, et al, *The New Calculus: Analyzing Airpower's Changing Role in Joint Theater Campaigns* (Santa Monica: RAND, 1993)

10. See Hallion, *Storm,* pp. 282-283; and, Global Reach, Global Power, p 12

11. This is not to say that we need all the capability we buy, especially in aggregate. Measuring procurement choices against real needs reveal many to lack cost-effectiveness in the broader sense.

12. "Major Changes Planned for Wild Weasel Force," *Aviation Week and Space Technology* (5 Jul 1993).

13. “GPS Plan Would Equip All Air Force Planes by End of 2000,” *Defense Daily,* 22 Jan 1993.

14 "GPS Drops Cost, Boosts Accuracy of Smart Bombs," *Defense News,* 22 Mar 1993.

15 "Precision Bomb Programs May Merge," *Aviation Week and Space Technology,* 27 Sep 1993.

16. Former USAF Secretary Donald Rice made this case in testimony before the House Armed Services Committee for the FY 1992 budget. See "In Wake of Desert Storm Air Force Touts Stealth," *Defense Week,* 4 Mar 1991.

17. "F-117 Pilots, Generals Tell Congress About Stealth's Value in Gulf War," *Aviation Week and Space Technology,* 6 May 1991

18. Brigadier General Hubert Merkel, deputy general manager of the NATO European Fighter Management Agency, quoted in "German Official Says Nothing Can Replace EFA," *Defense Week,* 1 Jul 1991.

19. David Evans, "Is the B-2 Bomber as Stealthy as the Air Force Claims," *Chicago Tribune,* 17 Jan 1992; Stephen C. LeSueur, "Lawmaker questions true value of low-observable technology; Iraq's Radar Tracked Air Force's F-117 Stealth Fighter During Persian Gulf War," *Inside the Pentagon,* 5 Dec 1991, pp. 1, 11-13; Daniel Plesch and Michael Wardell, "Stealth Fighter Uncloaked in Gulf War: British radar apparently picked up the F-117 up to 40 miles from its targets. Should we worry?", *LA Times,* 1 May 1991; Michael White, "Stealth Defence Pierced," *The Guardian* (UK), 25 Mar 1991; and, Malcolm W. Browne, "French Article Says Saudi Radar Can Track US Stealth Fighters," *New York Times,* 20 Sep 1990.

20. "SAC Chief Says B-2 Will Meet Specifications," *Defense Daily,* 15 May 1992.

21. "Advanced Antennas Expected to Reduce Jamming of GPS on RVs," *Defense Daily,* 26 Oct 1993.

22. "Mideast Nations Seek to Counter Air Power," *Aviation Week and Space Technology,* 7 Jun 1993; and, "Weapon Systems Without GPS Aren't Worth Funding – SASC," *Defense Daily,* 6 Aug 1993. The US Senate Armed Services Committee has recommended that the Department of Defense investigate the threat of hostile GPS use. In a distressing spiral, such use further encourages the development of precision offensive attack systems that target opponents' ballistic missile systems in their boost and ascent stages or earlier. GPS technology is a double-edged sword. Building weapon arrays and doctrinal concepts on it brings tremendous risk.

23. Lt Gen Buster Glosson, USAF, "Impact of Precision Weapons on Air Combat Operations," *Airpower Journal* (Summer 1993), p. 8.

24. Cohen, *GWAPS Summary* (Draft), Chap 3, p. 16.

25. *Harvard Study Team Report: Public Health in Iraq After the Gulf War* (Cambridge: Harvard School of Public Health, 1991)

26. Thomas A. McCain and Leonard Shyles, eds., *The 1000 Hour War: Communication in the Gulf* (Westport: Greenwood, 1993).

27. Robert Pape, "Coercion and Military Strategy: Why Denial Works and Punishment Doesn't," *Journal of Strategic Studies* (Dec 1992), pp. 423-475; and, Pape, "Coercive Air Power in the Vietnam War," *International Security* (Fall 1990), pp. 103-14.

28. Cohen, *GWAPS Summary* (Draft), Chap 3, p. 25.

29. Cohen, *GWAPS Summary* (Draft), Chap 3, pp. 9-26, 32

30. Cohen, *GWAPS Summary* (Draft), Chap 3, p. 32

31. Cohen, *GWAPS Summary* (Draft), Chap 3, p. 16-21

32. Cohen, *GWAPS Summary* (Draft), Chap 3, p. 27

33. This calculation is by combat sortie with support sorties distributed among the combat sortie categories. Borrowing from the *GWAPS* some adjustment is made to reflect numbers of strike per sortie. Allocation of support aircraft is approximate only, but reflects "depth" of target category and use of "stealth" aircraft. For raw totals see *GWAPS Summary*, Chap 3, pp. 15-41; and, *Conduct of the Persian Gulf Conflict: An Interim Report to Congress* (Washington DC: US DOD, 1991), Chap 4, pp. 2-5; and *Conduct of the Persian Gulf War: Final Report to Congress* (Washington DC: US DOD, 1992), Chap 7, pp. 197-214.

34. Col. John Warden, *The Air Campaign* (Washington DC: National Defense University Press, 1988), pp. 11-12.

35. Cohen, *GWAPS Summary* (Draft), Chap 4, p. 17-18

36. *GWAPS* also found that the amount of equipment in the theater pre-war turned out to be less than CENTCOM originally estimated. The final tally of equipment lost to air power prior to the ground war was more than 1300 tanks, almost 1200 artillery pieces, and about 900 APCs. Cohen, *GWAPS Summary*, Draft, Chap 1, p. 18; Chap 3, pp. 42-43.

37. Cohen, *GWAPS Summary*, Draft, Chap 3, pp. 33-39, 42-46

38. For perspectives on military development in less industrialized states see Stephen Biddle and Robert Zirkle, *Technology, Civil-military Relations, and Warfare in the Developing World* (Alexandria, Virginia: Institute for Defense Analysis, 3 Sep 1993); Carl Conetta and Charles Knight, *Reasonable Force: Adapting the US Army and Marine Corps to the New Era* (Cambridge USA: Commonwealth Institute, 1992), pp. 35-38; and Stephanie Neuman, ed., *Defense Planning in Less- Industrialized States* (Lexington USA: Lexington Books, 1984).

39. Cohen, *GWAPS Summary*, Draft, Chap 3, p. 47; Conduct of the Persian Gulf War, Final Report to Congress, pp. 174-176