The Future of Armored Warfare

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We miss our animals. Since history closed the mounted arm's stables, soldiers have compensated by naming their units after dragons, lions, panthers and their great lost love, the horse. Tankers, especially, like to associate themselves with the sleek and ferocious. Unfortunately, the armored vehicles of the next century are apt to resemble hedgehogs, snakes, and caterpillars. Perhaps, someday, a hard-bitten NCO will slam down his beer mug, stand up and declare, "I'm from the Woolly-Bears, mister, and we don't like that kind of talk . . . ."

Armored vehicles will be around for a long time to come. But their shapes, sizes, weights, armor, armaments, propulsion, connectivity, battlefield awareness, and crewing will change profoundly. The continuity will be in the mission: to deliver local killing power and allow protected maneuver. The evolution of armored vehicles will be driven by technology and strategic requirements, but, above all, by the changing environment of combat: the increasing urbanization of warfare, and the growing transparency of traditional non-urban operations--in which we will be able to monitor the activities of enemy forces in real time. Far from being the twilight of the tank, the new era could become a great age of armor, but only if proponents and practitioners of mounted combat are willing to engage the future in a spirit of honest inquiry.

The hints that Armor needs to reform itself grow ever harder to ignore. First, in the Gulf War, it took an Infantryman to recognize that the ground battle had opened in the pursuit phase. Too many armored commanders sought to fight textbook battles--and the textbooks were outdated editions that elevated secure flanks above knock-out blows. Then came the Russian experience in Grozny. Our reaction was to mock Russian incompetence and repeat the old saw that you don't send armor into cities. We failed to recognize the future, just as Europeans, content to assume American military incompetence, failed to appreciate the killing power of rifled weapons demonstrated in our Civil War. Half a century later, the Europeans reprised Cold Harbor on a vast scale on the Somme. Will we re-enact the Battle of Grozny?

Yes, the Russians were militarily incompetent in Chechnya. On the other hand, they had no choice but to use armored vehicles in city streets--like all advanced armies, they lacked the infantry strength to reduce the city building by building. Between these two examples, our soldiers found themselves in deadly combat in Mogadishu under conditions that begged for armor. Apart from the political considerations that denied our troops the tools they needed to overwhelm their opponents, the military itself was guilty of relying on traditional approaches to urban operations that are no longer feasible when domestic elites panic in the face of casualties (friendly or enemy).

The lessons of these examples are many, but the core challenges come down to a few points. Mounted warfare in non-urban environments goes very fast, and will go faster. Traditional control measures are inadequate. Battlefields quickly become cellular and multi-directional, and therein lies more opportunity than danger for the force with informational superiority and a leadership unafraid of the initiative of subordinates. While rigorous training and equipment quality are essential, the key variable is situational awareness--both the practical kind that means seeing the enemy tank before it sees you, and the deeper sort of command visualization that allows a leader to understand not only the physical reality of the enemy situation, but, more important, the situation as the enemy perceives it.

In the future, formations will operate far more swiftly and in smaller increments than in even the most successful divisional attacks during Desert Storm, but this is the reborn paradigm: Go fast, hit the enemy's weaknesses, keep on hitting him, and don't stop moving. This is very old military wisdom. Somehow, somewhere between the National Training Center and Carlisle, many of us forgot it. Too often, we elevate safety of decision over decisiveness. We may admire Jackson, but we imitate McClellan.

The lessons of Chechnya are even more relevant than those of our incomplete victory on the banks of the Euphrates. In the lethal urban canyons of Grozny--rather a small city, by world standards--the Russian military urgently needed means of protected fire and movement. They were forced to use what they had, and what they had was wrong. Equipment designed for war in the European countryside, flawed tactics, and grossly inadequate training and command and control led to disaster. The Russian experience does not prove that armor was the wrong answer, only that the Russians had the wrong kind of armor--and used that badly.

The key to the future of armored warfare lies in disregarding what we expect a tank to be in order to focus on what we need the tank of the future to do.

Tomorrow's Armored Force

On those disappearing battlefields that do not center on urban environments and complex terrain, tanks will remain recognizable for at least a generation. We will see changes in lethality, protection, propulsion and weight, but the greatest advance will be in battlefield awareness. On-board, remote, and even strategic sensors will give our tankers a commanding view of the battlefield, and there will be a window of frustration as their vision outstrips their engagement range. Eventually, tanks will gain a much deeper, indirect-fire capability, and sensing munitions will make an increasing proportion of land engagements resemble over-the-horizon naval warfare. These extra-urban tanks will become lighter, and will go faster. Miniaturization of components, from engines through communications gear to ammunition, will pace advances in armor to make systems more rapidly deployable. Eventually, the tank's primary "armor" may be electromagnetic or may otherwise take advantage of physical principles we are only beginning to exploit. We can imagine developments from "battles of conviction," in which opposing combat systems struggle to "convince" each other's electronics to enter vulnerable configurations, to weapons that literally stop opponents in their tracks by manipulating the local environment. Many experiments will fail, but some--possibly the most radical--will succeed.

Despite protection advances, crews will remain the most vulnerable link in the armored warfare system. This will be compounded by the proliferation of weapons of mass destruction. Eventually we will see a variant of remote-control tanks operated by displaced crews that remain well apart from the advance--perhaps as much as a continent away. Rather than merely requiring a private with a toggle switch, the complexity of decisionmaking will probably call for at least a two-man "crew" (per shift) even for robotic tanks. Virtual reality control environments will keep things lively. It is also possible that future tanks will be dual capability--normally directly crewed, but capable of remote operation under extreme threat conditions.

To complement the tanks, we will develop hyper-protective troop carriers to facilitate those dismounted activities indispensable to land warfare. But even here robotics will play a role so that we can operate under conditions created by weapons of mass destruction without soldiers present (although a human battlefield presence will always remain desirable--and usually essential). We may have to rethink mounted operations in the outyears: remotely-crewed vehicles can maneuver through intervening, high-threat terrain while soldiers are air-delivered to link-up points in or near populated areas or complex terrain we cannot ignore. Tangentially, we are likely to develop vehicles with a come-when-I-call robotic capability, as well as specially-intelligent tanks and troop carriers and, further along, "self-healing" vehicles that can repair and even remold themselves in response to battle damage.

"Flying tanks" have long been objects of speculation, but it is likely that fuel-logic and the psycho-physical dynamics of battle will demand grounded systems for many years to come. While attack helicopters already incorporate many of the characteristics previously imagined for flying tanks, we have found them a complement to, not yet a substitute for, armored vehicles. If we do work toward flying tanks--in the interests of systems economy--the more successful approach would probably be to ask how helicopters could change so that they can move, shoot, and survive on the ground. Aircraft are conceptually more mutable than ground systems, and, if the flying tank proponents are right, this might become the back-door means to change the parameters of armored warfare. A very real danger, however, is asking any system to do too many things, resulting in a system that does nothing especially well. Striking a proper balance between specificity of purpose and flexibility of application is a fundamental systems-design problem.

The relationship between direct and indirect fire means will also change. As noted above, tanks will acquire a longer-

range precision capability. At the same time, aircraft and then orbital platforms will deliver an ever greater proportion of the firepower we apply to combat in open areas. Great advances are on the horizon for fire coordination, and we are likely to see simultaneous joint attacks on complex targets by tanks, satellites, and hunter-killer computers. As with the Armor branch, Field Artillery needs to break from means- centered models and focus on the required ends. The alternative is to decline into the role of niche player--too heavy to deploy rapidly, too clumsy for urban operations, and a non-player in the information battle. While the goal of warfare will always be to destroy the enemy, the first step today is to inflict systems paralysis on conventional opponents, from air defense systems to command and control-- and, increasingly, to national information infrastructures. What will tomorrow's "artillery" look like?

The long-term trend in open-area combat is toward overhead dominance by US forces. Battlefield awareness may prove so complete, and precision weapons so widely-available and effective, that enemy ground-based combat systems will not be able to survive on the deserts, plains, and fields that have seen so many of history's great battles. Our enemies will be forced into cities and other complex terrain, such as industrial developments and inter-city sprawl, where our technical reconnaissance means cannot penetrate or adequately differentiate and our premier killing systems cannot operate as designed. We will become victims of our success. We are becoming so powerful at traditional modes of warfare that we will drive our enemies into environments where our efficiency plummets, our effectiveness drops, and close combat remains the order of the day. We will fight in cities, and we need tanks that can fight and survive in their streets.

The Changing Nature of Cities

Urban operations--the tanker's nightmare--will be the growth area for armored warfare. The world is becoming a network of cities with marginalized hinterlands. Increasingly, cities transcend statehood. In this contradictory world, where nationalism has returned in plague force, nation-states are softening. Cities as diverse as Vancouver, Frankfurt, Moscow, Miami, and Shanghai are growing apart from their parent states, for reasons that range from ethnic shifts in the population base to wealth concentration. Vancouver doesn't need the rest of Canada. Moscow doesn't much want the rest of Russia, except as an ornament of power and a looting ground. Shanghai may not be able to "afford" China indefinitely. Miami has become the shadow capital of Latin America--a focal point of information, culture, investment, banking, society, and exile. Frankfurt am Main is well on the way to becoming a "German" city with an ethnic German minority. An ancient paradigm is reversing: while cities long sucked strength from the diverse resources of the state, the state is increasingly becoming a parasite on the world's more-successful cities. This shift does not apply to cities such as Washington, D.C., or Marseilles, which would collapse entirely without state support, but it is very much the case in boom towns such as Hyderabad, Ho Chi Minh City, and Seattle. In the post-modern American model of dispersed cities, Silicon Valley has to foot the bill for failed governmental models in yesterday's cities--and every useful federal function performed in Washington, D.C. could be transferred profitably to Northern Virginia, were it not for habit and sentimentality. Suburbia is becoming "posturbia," and even in Ireland and Britain, the industries of the future are moving toward capable populations, instead of expecting the hands and minds to relocate to cities where the quality of life is abysmal. In this tiered construct, boom cities pay for failed states, post-modern dispersed cities pay for failed cities, and failed cities turn into killing grounds and reservoirs for humanity's surplus and discards (guess where we will fight).

Human clustering has left behind the village (the primary node of human organization until the middle of the 20th century and humanity's moral arbiter) and is concentrating in these three models: *boom cities* (Munich, Bangkok, Seoul); *reservoir cities*, where humanity is held in suspension (Lagos, Johannesburg, Lima, Karachi, Calcutta, Los Angeles proper, Paris); and *dispersed cities* (the Washington area without the city of Washington, Silicon Valley, and the Los Angeles region without the city of Los Angeles). Of note, the dispersion of America's success functions, with the transition of suburbia to a wonderfully livable workplace, is as misunderstood as American culture--decried by elitists, it creates the highest, healthiest, and most desired standard of living in history--just as American culture is the world's all-time bestseller, despite condescending reviews. We're winning again.

We live in the most dynamic age in human history. The city--capstone of human organization--is growing, changing, producing fantastic wealth, and rotting. While numerous factors are involved, the primary catalyst of change is the information revolution. In this Age of Contradiction, the value of information has inflated, while the cost of information has plummeted. Information always generated power; today, it generates wealth at a breathless pace--and

cities (including America's "dispersed cities") are humanity's information banks. If we possessed the data to calculate an "information deposit coefficient" for the populations of cities such as the greater Boston area (winner) and Bombay (loser), we would probably be astonished at the per capita informational advantage in Boston. Compounding the problem, the information that is available in the world's loser cities is not only scarce, but generally inaccurate, episodic, and deformed by local prejudice.

While many cities and post-cities are growing richer, more powerful, and more efficient, others--especially in societies with information disorders--are becoming poorer (on a per capita basis), weaker in their ability to self-regulate, and unable to deliver the most basic services that allow human beings to coexist in great densities. Many of these reservoir cities are anarchies attenuated by apathy, and the apathy of the masses can transform itself very quickly into violence. We are entering a period when we will increasingly judge the success of cities and their environs before we concern ourselves with their moldering states. This will not be a global model--countries such as the United States (for all our urban problems) manage to maintain a symbiotic dynamism between city and countryside, bridged by "third way" development: those dispersed cities coalescing from culturally chaste suburbs, satellite enclaves of production, and the workload diffusion characteristic of information mastery. Foreign actors will have to contend with the USA, not just L.A., for the rest of our lifetimes.

But who cares about Upper Egypt if Cairo is calm? We do not deal with Indonesia--we deal with Jakarta. In our recent evacuation of foreigners from Sierra Leone, Freetown was all that mattered. For decades, we dealt not with the government of Zaire, but with the emperor of Kinshasa--and in the recent civil war in that vast African state (now renamed as yet another Congo), military progress was measured not in jungle traversed, but in cities conquered. India is well on the way to becoming a confederation of city-states disguised as a political unity. Hong Kong will be a fascinating laboratory for the relative power of the city versus the state.

There is no global village. The village is dying as a model, and it is dead as a source of power. Instead, a global network of cities and post-cities is emerging, of both the healthy and the faltering, whose elites interact across borders more efficiently and effectively than they interact with the populations of their own hinterlands. Our elites will be inclined to defend foreign elites, even at the expense of our own population (this is already the paradigm of US-Mexican relations and US-Saudi relations). Our future military expeditions will increasingly defend our foreign investments, rather than defending against foreign invasions. And we will fight to subdue anarchy and the violent "isms" because disorder is bad for business. All of this activity will focus on cities.

In the future, the term "urban warfare" will be a redundancy.

New Armor for Urban Warfare

Where does armor fit in? Today's armor, designed for a war that--blessedly--never was, is ill-designed for urban combat. Yet, until better designs reach our soldiers, we will need to make do with what we have. Ideally, that would lead to reassessments of our tactics and reorganization of our units. We have begun to accept the inevitability of urban operations, but the truth is that we are likely to resist significant preparations until a sizable number of our service members have been killed and our nation embarrassed. That is the price we pay for any military paradigm shift following a period of successful organizational performance: the world may have changed, but we won't "mess with success." At a time when the pace of technological and social change is without precedent in human history, our military is clinging to the past. We are behaving like a blue-collar union in a smokestack industry.

We can affect the out-years, though. If you catch decisionmakers on a good day, they *can* be persuaded to sign up for changes that will not begin to remold the force on their watch. We have a free conceptual environment for anything beyond a decade, and we need to take advantage of it by asking ourselves practical questions about the future employment of armor in urban environments: What do we need that armor to do? How would we like it to do it? What are the extremes of the possible?

Regarding firepower, armor for urban environments will need two types of guns--or one gun that can do a variety of jobs. We will need a crude blasting capability, and we will need maneuverable munitions that can follow an assigned target beyond the limits of pure ballistic trajectories. We need old-fashioned flechette-type munitions--or an innovative substitute--and we need rounds that can penetrate multiple layers of steel and concrete before exploding or

otherwise "blooming" a follow-on destructive capability. "Boomerang" weapons that respond instantly to attack and track the assailant until he or it is eliminated would be an especially powerful deterrent. We will need a counter-electronics capability and crowd control "weaponry." It is important not to limit conceptualizing to traditional guns; an ammunition-free technique that achieves the desired effect could become part of our weapons suite. Any means we could develop to isolate portions of the urban battlefield would offer a tremendous advantage. Again, it is essential to focus on the task, not the known means for performing that task.

But the primary job of armored vehicles in urban areas will be to protect maneuver, movement, and resupply. Because urban environments promise endless ambushes, we need new forms of armored protection--not just layers of steel, or laminate, or ceramics, or even reactive armor as it presently exists. Tomorrow's layers of armor will begin with spoofing techniques that complicate target detection on the part of enemy systems, before proceeding to environmental or atmospheric modification capabilities that defeat mines, distort the enemy's perceptions, and disrupt the trajectory and integrity of enemy munitions. Instead of today's rigid hulls and turrets, tomorrow's armor may be malleable, capable of reshaping itself in response to changing threat environments. Self-repair, and, in the following generation, self-healing of battle damage, are logical goals. Finally, "living" armor, with its principles based on biological models, may allow new levels of interaction among man, machine, and environment.

Armored vehicles for urban warfare must also be nimble. While long-range sustained speeds are not a requirement, a sprint capability is essential. The vehicles must be highly maneuverable--at least in some variants. Deployment requirements and the varieties of urban operations suggest a modular approach, either to total armored fighting systems, or at least to troop carriers. The ability to "task organize" vehicle size, power units, armaments, electronic warfare (EW) suites, and battlefield awareness capability is worth pursuing. Vehicles that could operate as compact individual entities or join together to form moving fortresses or to "circle the wagons" offer new flexibility. Armored "mother ships" could "feed" or harbor smaller vehicles and robotic devices. Robotic scouts might climb through rubble, navigate corridors, or explore sewers, followed by team carriers with human decisionmakers and actors. These would be backed up by caterpillar mini-fortresses that hustle through streets and possess not only offensive and defensive environmental controls, but segmentation and self-repair capabilities. The visual signature of our armored systems, to the extent we do not obscure them, should be composed to psychologically disarm the enemy, exploiting research on instinctive reactions to shapes, colors, sounds, and smells. Our systems should be sensually terrifying to opponents and intimidating to populations.

Urban warfare is three-dimensional. Armored vehicles, using drones or ground robotics or hyper-sensors, must not only be able to see into multi-story structures and down into sewers, subways, and service tunnels, but must be able to introduce soldiers--in a protected manner--to upper-story or subterranean zones of operation. Ideally, armored vehicles would be able to caterpillar above or snake below ground level, gripping the lower portions of structures, or entering subterranean passageways. This might be done with deployed subcomponents, such as team-capsule vehicles, or with extensions from master vehicles. The ability to cross exposed "ground" will be essential. A well-designed vehicle or extension might seal against a second story window, "sanitize" the immediate interior, and release soldiers from an armored gate. To some extent, the soldier himself might become an armored entity.

Secured areas might be outposted by robotics and picketed by soldiers cued by local fusion centers that combine intelligence from sources as diverse as miniature roaming sensors and national-level systems. Population control might be established by electronically registering every inhabitant with whom the force comes in contact and alerting in response to any human concentrations that do not fit habitation profiles. Eventually, body signature sensors should identity fear, hostility, or positive demeanors on the part of the locals. Any means that can be developed to separate the hostile actor from the "sea of the people" is highly desirable, since, in urban operations, the enemy's ultimate camouflage is his humanity.

A model urban operation of the future might begin with a massive information operations effort that attacks not only systems but souls. Air and space forces would then isolate the city electronically and through fires, attack pre-selected targets with precision munitions, suppress air defenses, and impose barriers between urban sub-sectors. Army robotics parachute in to secure airfields and landing zones, followed by air-delivered troops with light armored vehicles to extend the perimeter. The next wave includes heavier ground systems and more personnel delivered by air and, in littoral cities, by Navy-Marine operations. Robotic systems push deeper into the urban area, followed by armored

reconnaissance "moving fortresses," or combinations of separate vehicles, delivering firepower and dismountable forces to hostile zones. Behind the fighters, military police and intelligence personnel process the inhabitants, electronically reading their attitudes toward the intervention and cataloging them into a database immediately recoverable by every fire team in the city (even individual weapons might be able to read personal signatures, firing immediately upon cueing).

Wherever the enemy resists, joint operations isolate and reduce the threat zone. Smart munitions track enemy systems and profiled individuals. EW actions veil the movement of armored vehicles, remotely exploding mines as the vehicles move forward. Tanks and tank segments deliver direct and smart fires in a final barrage as troop carriers advance. The unit commander designates points of entry, and images of exteriors and interior layouts appear in the carriers for orientation. Carriers leech against buildings and subterranean passage entry points, collapsing the atmosphere at the points of entry to kill or disable any present enemies, before discharging troops. In extremely vertical environments, robotics and troops are air-delivered by systems that can spoof enemy sensors and vision into registering multiple images or completely false images. As soldiers clear the buildings--preceded by their individual sensors--they push their individual weapon's selector switch to "Inhabited," and, upon entering a room, the weapon does not discharge if pointed at a noncombatant without violent intent. Most friendly casualties are lost to enemy suicide attacks or come as the result of physical injuries received during fire and movement within buildings, such as broken limbs. When particularly stiff pockets of resistance develop, smart armor moves in to destroy them or soldiers cue stand-off precision weapons.

Other armored units move swiftly through the city to establish a mobile presence and seize control of line-of-communication nodes and routes of ingress to and egress from the city. In vast conurbations, lightweight, electronically armored systems are airlifted by rotary wing (or post-rotary wing) assets. Satellites monitor the city for any air defense fires, cueing immediate responses from near-space orbiting "guns." Drones track processed inhabitants who have been "read" as potentially hostile and "tagged." Any suspect concentrations draw immediate intervention. Non-lethal weapons control crowds and manage POWs. Operations continue 24 hours a day until the city is cleared of hostiles. When the environment is deemed acceptably safe, United Nations peacekeepers arrive to conduct the long-term operations necessary to restore or create an acceptable government and civil functions. US intelligence and electronic support continues, but US troops return to the United States or to forward bases to prepare for subsequent expeditionary actions.

Many of the hypotheses contained in this essay will never be realized--not because they are too far-fetched, but because they will prove inadequately imaginative. We will develop far more appropriate, incisive, and interesting solutions than those offered here. Yet, even if every avenue of development here proposed is wrongheaded, the urban operations challenge is real, immediate, and growing. We *will* fight in cities. Even when we are not fighting, we will operate in urban areas and in complex terrain on a variety of missions.

What guidelines will help us to accomplish those missions successfully? In future urban operations, whether in 1997 or 2027, the US military should strive to follow tenets such as these:

1. Extract a clear mission statement from decisionmakers.

2. Tell the American people there will be friendly casualties.

3. Establish unity of command and purpose.

4. Impose rules of engagement that favor US forces, not the enemy.

5. Deploy more combat power than you think you need, then increase it.

6. Operate offensively, never passively or defensively, and operate continuously.

7. Never allow local inhabitants to congregate in mass.

8. Do the job fast. If the job can't be done fast, get somebody else to do it.

9. Hand off the pacified city to non-US peacekeepers as soon as possible.

10. From first to last, fight and win the information war--on all fronts.

The physical contours of warfare have changed dramatically in our time, and they will continue to evolve. Thinking about the problem is a first step. The next step is to begin to prepare our remarkable military for reality.

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