MANOHAR PARRIKAR INSTITUTE FOR DEFENCE STUDIES AND ANALYSES
मनोहर पर्रिकर रक्षा अध्ययन एवं विश्लेषण संस्थान

MP-IDSA
Issue Brief

Mosaic Warfare: Redefining Future Battlefield

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April 27, 2020

Summary

A technology-driven major overhaul of conventional warfare seems inevitable in the near future. Smaller, smarter, potent and cheaper combat entities — linked and networked – will be at the heart of future warfare. With India struggling to cope with modernisation and acquisition challenges, it should be an endeavour to pay greater attention to the modernisation roadmap of its forces, to keep pace with future environment and challenges.

Elon Musk, Founder and Chief Executive Officer of the SpaceX Corporation as well as Tesla Motors, proclaimed at the United States Air Force (USAF) Air Warfare Symposium in February 2020 that the days of the fighter aircraft are over.[1] Unprecedented technological advances over the last half a decade or so portend an imminent transformation of warfighting. Many current warfare concepts are likely to become obsolete. A vast number of expensive, modern warfare equipment and weapon systems may be rendered useless, especially against a technologically advanced enemy. The issue brief examines the concept of Mosaic Warfare and brings to attention the inadequacy of current warfighting concepts in a networked battlefield. It concludes by highlighting the need for India to review its modernisation roadmap, in the light of ineludible changes impacting the nature of warfare in the near future.

Drivers of Change

Even as emerging disruptive technologies are ushering in massive changes for the military, it seems the transformative power of these technologies is not being adequately accounted for while preparing for future warfare. The probability that such disruptive technologies will prevail over human warfare skills is always a point of contention. Resistance to new ideas though seems to be less in technologically advanced countries. The USAF Chief General David Goldfein, for instance, acknowledged the unprecedented transformation in progress at the Dubai Airshow 2019.[2]

The warfare dynamics of future conventional conflicts would be dictated principally by a highly evolved multi-level networked environment, where the role of humans would be very limited. Network centricity of warfare is evolving fast and becoming a necessary ingredient for military advantage. Deep involvement of humans in warfare is likely to create friction, slowing down the pace of war and adversely affecting the outcome for the side relying more on human capabilities for analytics, kill cycles and observe, orient, decide and act (OODA) loops, rather than smart machines. This is due to lesser power of analysis, and slower perception and action-taking ability of the human vis-à-vis smart networked machines powered by artificial intelligence (AI), internet of things (IoT) and other disruptive technologies. These technologies are increasingly elbowing out humans from what is called as 'human-in-the-loop' to 'human-on-the-loop', and would likely leave them with only the veto power in most cases.

[1] Valerie Insinna, **"Space X's founder tells US Air Force the era of fighter jets is ending"**, *Defense News*, February 28, 2020.
[2] **"Video: Here's how the US Air Force is automating the future kill chain. Dubai Airshow 2019"**, *Defense News*, November 16, 2019.

Another major factor responsible for the changing dynamics of conventional warfare is the vast increase in the availability of modern high technology weapons in battlespaces. These weapons have increased precision, enhanced kill probability, easy mobility and transportability, as well as greater reliability. They have increased the lethality in the battle arenas, compelling a conceptual relook at the deployment and pitching of modern high value warfighting assets.

Many of the high value assets like aircraft carriers and airborne warning and control systems (AWACS) are so expensive that their loss in battle are irreparable in most cases. Previously considered unreachable by the enemy and mostly invincible due to their deployment and employment tactics, their vulnerability has been increasing with time due to the rapid evolution of effective counter weapons. Such expensive equipment and platforms are slowly becoming a liability and it will be increasingly difficult to field them in wars of the future. Even their value as a deterrent would go down as the adversary is fully in the know of their limitations.

Monoliths and Monolith Busting

Most of the modern weapon platforms like fighter aircraft and naval ships are expensive state-of-the-art systems with multiple capabilities housed in a single platform — making them highly capable fighting machines. They are generally multi-role, simultaneously taking care of a multitude of battlefield requirements like multi-spectral reconnaissance across the optical, radar, and infra-red (IR) bands, common operations picture (situation) build-up, threat detection, coordinated manoeuvring, target analysis, target selection, target designation, targeting (carriage and launch of multiple weapons), electronic warfare (EW), intelligence, surveillance and reconnaissance (ISR), data linking and communication, among others.

However, most of such platforms are exorbitant and can be afforded by only richer nations. These are now being termed as ‘monoliths’. While until now, these were seen as force multipliers, their efficacy in a battlefield is being increasingly questioned, given that the loss of a monolith would mean loss of multiple state-of-the-art systems in one go. With the passage of time, the rate of obsolescence of systems and technologies in monoliths is also likely to increase. The expensive systems in these monoliths may not remain effective long enough, requiring expensive upgrades.

The emerging solution to deal with the problem posed by monolith platforms like aircraft carriers or multi-role fighter aircraft or ISR platforms is termed as ‘monolith busting’.[3] This essentially implies distributing various capabilities and roles among a large number of low-cost, independent machines. These would be networked

[3] Explained by Tim Grayson, Director, Strategic Technology Office, DARPA. See Tobias Naegele, **“Mosaic Warfare: DARPA’s answer to combating America’s advanced foes”**, *Air Force Magazine*, September 11, 2019.

together, either directly or through a central Combat Management System network, to accomplish a mission as a package — in much the same way that a package of monoliths would perform. This networking concept is also called a 'system of systems'.[4]

The newer technologies comprising broad-spectrum analysis and autonomous action capabilities of AI, software-driven systems, flexibility and capacity of networks, miniaturised electronics, advanced materials like composites, etc., are enablers of such dynamics. These would have an inevitable presence in the battle arenas of tomorrow. The current products of these technologies like autonomous drones, robots, intelligent weapons, high capacity networks, satellites, etc., are trendsetters in the direction. Countries like the US are working on these capabilities to a significant degree. Serious thought is also being given to the possibility of using cheaper commercial-off-the-shelf (COTS) equipment — for instance, single-use drones suitably modified as weapons wherever possible, instead of military grade ones. Of course, this would have to factor in the reliability aspect so that the crucial turf is not lost due to the failure of the equipment.

Mosaic Warfare

Multiple terms have been coined for this distributed capability warfare. These include Mosaic Warfare, Lego Warfare and Distributed Maritime Operations (DMO). While DMO is a US Navy concept, mosaic warfare, on the other hand, is not limited to a single service (amplified later). These terms, pertaining to the tactical level employment of forces, have originated in the US to account for the changes in warfighting in the light of the progress in disruptive technologies.

The US Defence Advanced Research Projects Agency (DARPA) notes that "like the ceramic tiles in mosaics, these individual warfighting platforms are put together to make a larger picture, or in this case, a force."[5] Such a large number of battle arena entities would overwhelm systems or create functional difficulties for the enemy's command and control set-ups. Overwhelming or saturating the enemy's means with distraction and confusion is an old concept but here the degree would be far greater.

Distributed capability among a large number of systems in the battle arena would also reduce the capability loss per kill by the enemy, as against monoliths, where every kill would mean a substantial capability loss. The overall cost of losses would also be lesser. With a lesser number of systems lost, the availability of capabilities in battle arenas would be more. Apart from this resilience, the concept also brings increased flexibility, as each system would invariably be linked to one or more

[4] William A. Owens, **"The Emerging US System-of-Systems"**, *Strategic Forum*, February 06, 1996.
[5] **"DARPA tiles together a vision of Mosaic Warfare"**, *Defence Advanced Research and Projects Agency*.

complementary systems in the arena for completion of kill chains (sensor to shooter functions).[6] DARPA notes that "it doesn't matter what the enemy does, the [blue force] still has options for completing a kill chain". DARPA's former Strategic Technology Office (STO) Director, Tom Burns, points out that conventional wisdom says that the US forces shouldn't 'fight in the open - where combat entities are exposed'. But large numbers of expendable platforms allow for the ability to fight in the open as well as continue the war even in a nuclear, biological, chemical (NBC) scenario to achieve war objectives.[7]

Mosaic warfare, therefore, is an integrated warfare concept in which the roles of all the services (forces) operating in and/or overseeing an area or a geographical region will be complementarily integrated through networks for the achievement of objectives. For instance, the sensors and networks of the army will be integrated with air force drones for engaging chosen targets in the battle arenas. Currently, only information is shared between services rather than raw data on the tactical data links (directly between machines for targeting). Most nations will find the sharing of such raw data in a networked environment to be a technological challenge due to networking and protocol differences between the individual services. These difficulties, however, would be overcome eventually as integration increases. Like saturation, different sensor and shooter (separated physically) engagements are already in vogue, but at present are limited to individual services.

Another feature of such 'system of systems' would be a high degree of adaptability to the frequently changing environment in the battle arenas. No war progresses as planned and therefore will require continually evolving force combinations.[8] The AI in battlefield systems and the overarching Combat Management System will be geared to enable a particular sensor or weapon that would be best suited for a particular threat and may reassign systems to engage that threat. Self-healing in case of losses would be an intrinsic characteristic of such a package of combat entities.

The role of the human in the entire gamut is likely to increasingly shift to 'on-the-loop' that is more of higher command functions like setting the objectives, situation monitoring and managing the logistical challenges rather than micro-managing the action in the battle arena. In the initial action of battles, humans are likely to be only in a complementary role to the machines due to the higher expected attrition (as a result of the increased lethality). However, in the subsequent action, the role of humans is likely to increase. How the war would take place would depend on power

[6] For example, attacking a tank – post successful attack the designating equipment can link up immediately to another shooter for another target. Even in case of destruction of the designator, another autonomous can take place of the destroyed one.
[7] "DARPA Tiles Together a Vision of Mosaic Warfare", no. 5.
[8] Benjamin Jensen and John Paschkewitz, **"Mosaic Warfare: Small and scalable are beautiful"**, *War on the Rocks*, December 23, 2019.

disparity and technological prowess of the warring sides. The technologically advanced side would distinctly have advantages.[9]

Jensen and Paschkewitz note that the mosaic warfare concept has evolved consequential to extensive war gaming across both land and maritime scenarios over the last few years in the US. In war gaming, the concept seemed to permit more aggressive war manoeuvres than possible with monoliths, as losing a low-cost drone in the hunt for gaps to exploit the situation was an acceptable gamble. The authors note that rather than employing a fifth-generation fighter at risk to probe and suppress defences, the players employed cheaper unmanned systems in the games to assess the opposition's force disposition and take losses without jeopardising their main effort.[10] Such immense advantages are likely to lure nations – especially those in more volatile regions and under threat from bigger powers, to undertake appropriate forces build-up to exploit such dynamics to gain tactical advantages.

Future Transformations

In the coming decades, despite increasing automation, doing away with monoliths is not likely to happen in totality, even for major powers. In all likelihood, a gradual changeover will be seen, with the pace depending on a number of factors like the nature of the threat, rate of advancement of technology, access to technology, etc. In the foreseeable future, the force package for any particular objective or mission would probably only shift to a mix of manned and unmanned platforms/systems, with the share of unmanned ones over the manned increasing as technology advances. The new generation unmanned platforms would be more attritable in nature, that is, they could be exposed to higher risk. Such platforms would range from light reconnaissance systems to heavy weapon systems.

A large number of cheap decoys would be intermixed in most of the packages for making the situation more difficult for the enemy. In fact, all available weapons and systems in the arena — whether cheaper or expensive, manned or unmanned, short-range or long-range, would be flexibly tiled together to form a mosaic to prosecute operations. Tiling would permit flexibility in deployment unlike the more rigid jigsaw nature of deployments today. For major powers, advanced modelling and simulation enable quicker development of systems/weapons /concepts.

While DMO is a similar concept applicable in the naval domain, it is more reliant on distributed firepower concentrated in combat ships. The concept aims at augmenting the firepower of ships and giving them more independence in operations. For example, a ship in the carrier battle group (CBG) may be tasked to temporarily detach

[9] See Atul Pant, **"Internet of Things Centricity of Future Military Operations"**, *Journal of Defence Studies*, 13 (2), April-June 2019, pp. 25-58.
[10] Benjamin Jensen and John Paschkewitz, no. 8.

and engage a target in the area which is being tracked and designated by another sensor somewhere else, before coming back to CBG again. The US Navy sees the concept fructifying in the early 2030s.

Historically, the concepts of naval operations have always been founded mainly on combat power of large ships. Of late, missiles in these ships have become potent means of delivering naval firepower. However, given the increasing anti-ship lethality of modern weapon systems (and more so in future), the viability of the concept is coming under question. These advanced missiles are now finding a place in military arsenals. These include LRASM (US), Sea Venom (France and the United Kingdom), X-ASM (Japan), KH-47 Kinzal (Russia), Kongsberg Naval Strike Missile (Norway), Brahmos (India), and YJ-12 and DF-26 (China). Analysts note that such modern anti-ship missiles are "hard to evade, outrun or out-turn once a target has been acquired. To counter the threat, the modern surface ship has to avoid being detected, or has to decoy or destroy all of the incoming missiles or their missile launch platforms – ideally destroying the latter before missiles have even been fired."[11]

The DMO in all likelihood will get juxtaposed with the mosaic warfare concept where the lethality of big ships would be distributed to a great extent across smaller surface ships (fast stealth missile crafts) and aerial platforms (like the new generation drones). Analysts like Kevin Eyer and Steve McJessy note that while the jury is still out as to how DMO will take shape, the US naval community is well aware that major changes are in the offing and there is an understanding of the inevitability of the shift to unmanned platforms.[12] The involvement of these unmanned platforms in non-lethal roles is also not very far away, as the trends indicate.

The idea of mosaic warfare would be even more appealing to smaller powers due to the concept providing more value for investments, more security for their forces and a force multiplier effect – with a higher possibility of unexpected big gains. The mosaic concept would be scalable with applicability from surgical operations to large-scale battlefield action. In such warfare scenarios, cyberwar, EW and electro-magnetic pulse (EMP) weapons will vastly complicate the battlefield as these weapons are likely to be big game changers in the mosaic warfare concept.[13] They can neutralise a range of battle arena electronic entities and compel recourse to rudimentary warfighting. This would eventually make warfighting more expensive.

The heart of mosaic warfare is continually evolving networks in the battle arenas — both at the micro and macro levels, which have to be protected and made resilient. An improperly designed network would probably be the weakest link during the

[11] Jon Lake, **"Anti-Ship Missile Evolution"**, *Asian Military Review*, January 10, 2020.
[12] Kevin Eyer and Steve McJessy, **"Operationalizing distributed maritime operations"**, *Center for International Maritime Security*, March 05, 2019.
[13] At present, EMP weapons are in an experimental stage. See Atul Pant, **"EMP weapons and the new equation of war"**, *MP-IDSA Comment,* October 13, 2017.

action. Apart from this, there are a plethora of issues that would need to be addressed, even for countries like the US, for changing over to this new form of warfare. These include revising doctrines, addressing technical aspects like power requirements for combat entities, resolution of networking protocols, management of refuelling, maintenance and rectification requirements, acquisition and procurement procedures, recovery of unused weapons, etc. Eventually, with the comprehension and understanding of inescapability of the concept, solutions would no doubt emerge with time. At present, the issue is that technological innovation and development have assumed such an accelerated pace that people are finding it difficult to comprehend new technologies or grasp their future manifestations, often leading to wrong investments.

While other major powers may not have come out with such explicitly stated visions of future military operations so far, their military systems development trajectories and occasional proclamations are indicative of their envisioning a similar future. This is further attested by the availability of a large number of research papers, articles and news reports on the subject, apart from governmental and institutional releases. A new land warfare robot for the Chinese People's Liberation Army (PLA), for instance, is reflective of this trend. New robots being inducted into the PLA are indicative of unmanned systems gradually replacing human soldiers from "heavy physical work and extreme danger," and instead letting them "focus on combat decisions and carrying out technical and tactical movements …"[14]

Gestalt

A technology-driven major overhaul of conventional warfare seems inevitable in a decade-and-a-half or so. A shift to distributed operations will start gaining centre-stage as the vulnerability of high-value assets increases with the proliferation of more sophisticated longer-range weapons. Smaller, smarter, potent and cheaper combat entities — linked and networked – would be at the heart of such warfare. Innumerable advantages that would accrue as a result of such distributed warfare include reduction of exposure of forces to harm, execution of dangerous (as well as dull) missions, among many others. Such advantages would no doubt persuade major global powers to adopt new warfare concepts like mosaic warfare more swiftly.

While investing in and imbibing these futuristic concepts would be easy for global economic majors, other nations can ill-afford to overlook these anticipated transformations. The penalty in case of a conflict with technologically advanced militaries could be heavy – both in terms of costs and lives. With India's precarious environment amidst two hostile adversaries, especially with one galloping ahead in

[14] Liu Xuanzun, **"Robot warriors join Chinese military arsenal, will free soldiers from dangerous missions"**, *Global* Times, April 14, 2020.

military modernisation, it is time to re-evaluate future options as any policy changes would take more than a decade to come to fruition. A concept like mosaic warfare would have very different needs than what may be envisioned currently. With the nation struggling to cope with modernisation and acquisition challenges, it should be an endeavour to pay greater attention to the modernisation roadmap of its forces, to keep pace with the future battlefield environment and its attendant challenges.

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