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CONCENTRATED FIREPOWER VS NUMBERS IN WARFARE

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In the past few years there has been a resurgence of interest in developing the ability to make small relatively less capable systems operate in a co-operative manner. This interest has led to adoption of the word 'swarm' to refer to the new developments. Examination of the concept leads to the finding that as a concept swarms have been used in warfare from ancient times. Further it becomes clear that there has been an ongoing debate on the relative merits of numbers verses higher technology.

Background

The debate about the relative merits of high technology / firepower / killing power centred in a few discrete warriors against relatively less capable individual fighters in larger numbers has been on since early times. While in ancient times numbers mattered more than anything else in the attrition warfare then in vogue, advances in weaponry resulted in combatants with high combat power and strong defences along with respectable mobility. The medieval Knights represent this change; these horses mounted Knights were able to move fast despite their heavy armour and wielded a mix of weapons comprising swords, axes, and lances and cross bows. Counters effective against Knights were opposing Knights in most cases. However, it was found that surrounding the heavily armed Knights and carrying out multiple near simultaneous attacks by foot soldiers on the Knights could yield success.[i] The relatively lightly armed foot soldiers could be said to swarm around the Knight in such situations. The Industrial Revolution led to warriors

fielding ever more advanced weapons. Introduction of firearms able to penetrate even the densest armour then available led to the demise of the medieval Knight.[ii] Militaries all over the world still regarded heavily armed combatants with high killing power very desirable. Further industrial advances finally led to the fielding of battle tanks on land.[iii] These machines carried very heavy armour that was impervious to all but very heavy calibre weapons that could be carried only by other tanks.[iv] Initially main battle tanks (MBTs) were thought to be invulnerable on the battlefield. As was inevitable counters to tanks continued to be sought for. In time specially designed anti-tank artillery guns were developed.[v] These led on to lighter man potable weapons such as the bazooka (a tube that launched a projectile designed to penetrate tank armour.[vi] Still later anti-tank guided missiles provided the individual infantryman with enough firepower to kill a tank. The tank still remained a very powerful opponent given its main cannon and typically a heavy machine gun mounted on the turret. A tank despite its bulk had the ability to outrun dismounted infantry and so could choose to fight where it wanted to, a decisive advantage in combat. Infantry's answer was to develop tactics wherein individual infantrymen could approach a tank from different directions near simultaneously to evade the tank's heavy armament and destroy it through well placed armour piercing projectiles (or in other words infantry could swarm around the tank giving it multiple potentially lethal targets to engage at the same time thus defeating its ability survive the fight).[vii]

The equivalent of the tank at sea was the dreadnought.[viii] These ships featured very heavy armour and very heavy guns mounted on board and were regarded by marine specialists to be unsinkable. Experience in war showed even these dreadnoughts to be vulnerable to near simultaneous attack by less capable opponents that operated in co-operation to mount co-ordinated attacks.[ix]

In aerial warfare the ultimate attacking aircraft developed in the early twentieth century was the heavy bomber. These aircraft could carry a relatively large payload of bombs. To defeat opposing defenders these were equipped with gun turrets located at various crucial parts of the fuselage. These gun turrets were designed to provide overlapping arcs of fire. Two outstanding examples of these machines were the US B-17

"Flying Fortress" and B-29 "Super Fortress". The theory was that enemy fighters trying to shoot down the heavy bomber would be destroyed as soon as they entered the arcs of fire of the defensive gun turrets. In practice it was found that intelligent attacks put in by defending fighters on bombers could on some occasions penetrate the defensive fire and kill the bomber. The use of larger numbers of fighters that 'swarmed' around heavy bombers achieved better results as the concentrated firepower possessed by the bomber was split between multiple targets.[x]

The underlying debate between the choice between concentrated firepower and numbers continued to guide military development and tactics. Ideally very large numbers of weapons systems with highly concentrated firepower would be ideal. However, issues of cost, industrial, and technological capabilities often force choices in the real world. In more recent times by and large the industrialised West has favoured concentrated firepower in very capable advanced weapons systems. The US super carriers are the best example of such equipment as are the very capable modern fighters, such as the F-15 "Eagle" and F-16 "Falcon" fielded by the US. Soviet era aircraft generally tended to be much more rugged though less technologically advanced than US equipment. However, these Soviet designs featured simpler technologies and techniques that facilitated relatively easy and cheap manufacture of much larger numbers for a similar cost.[xi] Larger numbers of less capable opponents were expected to be able to prevail over the fewer but more advanced opponents. Hungarian MiG-21s of Soviet vintage carried out mock combat training against advanced US aircraft such as F-16C/Ds in the later 1990s / early 2000s. The F-16 easily prevailed over the 1950s era MiG-21s at large to medium combat ranges; however, at close ranges the use of larger numbers of MiG-21s enabled at least one of the MiGs to close in adequately to claim as victory on the F-16.[xii] This illustrated the ability of 'swarms' of less capable fighters to overcome more advanced and potent opponents just as medieval Knights could at times be overpowered by larger numbers of relatively lightly armed foot soldiers. It is generally believed that the Peoples Republic of China (PRC) adopted a strategy of swarming over and defeating invaders in the early years of its existence. This strategy was forced through the technological backwardness of the country and relative advantage of its main perceived opponents. The "Peoples War" concept was based on

letting an invader enter deep into PRC territory with only light opposition. Once the invader had penetrated adequately into PRC territory to have a long and vulnerable line of supply, large numbers of less well equipped PRC troops would then swarm around the invader and destroy him. Even in the air the PRC's Peoples Liberation Army Air Force (PLAAF) adopted a similar strategy for the same reasons.[xiii]

Swarm Technology

The debate about the relative merit of a few very capable war machines and a larger number of less capable equipment has continued for generations. Apart from the historical narrative on the development of capital weapon systems and counters to these by 'swarms' it is relevant to examine possible reasons for the renewed interest in 'swarms' even for modern cutting edge weapon systems. A few of these merits are as below:-

- 'Swarms', of relatively inexpensive sensor carrying, vehicles could be used on intelligence gathering missions. Here in case a few of these were to be destroyed by enemy action or other reasons the mission could still be achieved though with some loss in results achieved. This could be preferable to deployment of a single highly capable intelligence gathering asset the loss of which would result in zero results from the mission quite apart from the loss of the platform. Similarly it has been recognised that Airborne Warning and Control Aircraft (AWACS) are crucial for decisive victory in aerial warfare. These AWACS are

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today classified as High Value Airborne assets (HVAA). The loss of an AWACS could have disastrous consequences both in terms of the loss of an expensive platform as well as the sudden loss of the radar capability provided by AWACS. Alternatively especially with availability of lighter Active Electronically Scanned array (AESA) technology radars today it could be possible to field a 'swarm' of small vehicles each carrying AESA radar elements to build a very capable airborne radar replacement for the current AWACS with similar or even better capability. Such a radar 'swarm' would effectively be akin to compound eyes found in insects. In case of enemy action against the radar swarm destroying a few of the airborne radar element carrying vehicles, the remaining members of the radar 'swarm' would be able to function, with maybe a little loss in overall capability. In both these hypothetical situations above a characteristic of 'graceful degradation' is seen to exist in 'swarm' based technologies. This 'graceful degradation' is a desirable characteristic for any combat or combat support system to have.

- A 'swarm' would also be scalable unlike the one size fits all situation of current weapons platforms. Hence today an AWACS is deployed in situations where a smaller system could suffice. A 'swarm' could easily be scaled up or down through control over the number of elements tasked fir a particular mission within required assurance levels and capability requirements.
- In case the overall attack capability of an attacking force were to be split between numerous independent sub elements that operate co-operatively, the ability of this 'attack swarm' to penetrate enemy defences could be improved. Assuming that enemy action destroys a percentage of the 'attack swarm' elements, the remaining elements could be able to reach the designated target and inflict required damage especially in a world of precision guided munitions (PGMs) and Directed Energy Weapons (DEW).
- Modern multirole combat systems whether on land, in the air or at sea are very complex and costly weapons. However, the individual elements of a swarm could be relatively simple and inexpensive in view of their operational expendability.

- Technologies required for building individual elements of a swarm could also be relatively simpler than those required for advanced 'capital' weapons systems.
- Countries with a robust information technology (IT) sector could be at an advantage in embracing the 'swarm,' concepts and development. This is because there is likely to be need for extensive IT involvement in developing the algorithms for individual elements of a 'swarm' to operate co-operatively without close human involvement.

To sum up the advantages of swarm technology are:-

- flexibility,
- ability to scale up or down the system to suit current operational needs,
- graceful degradation of capability in battle, and
- Higher assurance of penetration of hostile environments.

A few know development projects in this field are the US DARPA sponsored swarm technology for drones. This project involves enabling a large number of drones to operate together without human involvement.[xiv] Though currently at the technology development stage DARPA could be expected over the next few years to move towards operationalising 'swarm' technologies for the US armed forces. there is some stray mention on 'swarm' technologies in Western Europe but no openly known project to develop 'swarm' technologies in Europe, Russia, or China.

While the future remains uncertain and clouded in grey this trend towards inbuilt swarm capability in future weapons systems appears certain.

IAF's light end of its desired combat mix could at a stretch be considered a n acknowledgement of the 'swarm' concept wherein larger numbers of less expensive machines are used in place of fewer more expensive machines. However, there is no known move by the Indian armed forces or by Research and Development (R&D) agencies in the country to commence development of 'swarm' technologies. Given the advantages that 'swarm,' technologies could provide fighting forces it could be prudent for the country's

scientific community and end users to look seriously at initiating R&D into this field. Such a move could be especially beneficial give the IT expertise available in the country.

Conclusion

From ancient times warring parties have tried to field heavily armed and armoured combatants. This trend can be traced from the medieval era till as later as the Second World War and even to current times where the MBT still forms a crucial part of most armies' battle line up. In parallel the history of warfare shows the use of relatively lightly equipped forces to counter the more powerful 'capital' combat elements through use of superior numbers. In addition to the use of numbers to counter stronger opponents larger numbers deliver several other advantages such as flexibility, scalability, graceful degradation etc. in the modern era there is renewed interest is use of swarms of smaller individual systems to carry out tasks hither-fore reserved for much more expensive and complex platforms. As IT is likely to be a deciding factor in the new 'swarm,' technology some countries could derive great benefits through commencing R&D in this area.

(Disclaimer: The views and opinions expressed in this article are those of the author and do not necessarily reflect the position of the Centre for Air Power Studies CAPS)

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