

CENTRE FOR LAND WARFARE STUDIES (CLAWS)

FIREPOWER INDIA: 2013

22 MAY 2013

SEMINAR REPORT

General

The Centre for Land Warfare Studies (CLAWS) in association with *India Strategic*, organised a daylong seminar on 'Firepower India: 2013' on 22 May 2013 at Manekshaw Centre, New Delhi. The seminar gathered noted experts on the subject to discuss various aspects of developments in missile technology, unmanned systems, aircraft carriers, and aero-space dominance. The keynote address was delivered by Lt Gen Narendra Singh, AVSM, SM, VSM, DCOAS (P&S). The inaugural address was delivered by His Excellency Shri Shekhar Dutt, Governor of Chhattisgarh. A special address was delivered by Air Mshl SB Deo, AVSM, VM, VSM, DG Air (Ops), IAF. Air Mshl M Matheshwaran, AVSM, VM, DCIDS PP & FD, HQ IDS delivered the valedictory address. The seminar was well attended by serving and retired officers of all three Services, members of the strategic community, and from the defence industry sector.

Inaugural Session

Welcome Remarks – Maj Gen Dhruv C Katoch (Retd), SM, VSM (Retd), Director CLAWS

It gives me great pleasure to welcome you all to the CLAWS-India Strategic joint seminar on "Firepower India 2013." CLAWS has been organising this seminar with India Strategic every year since 2009 and "Firepower India: 2013" marks the 5th seminar in the series of Firepower India seminars. The focus of attention on firepower throughout history has been the armies with bigger guns invariably coming out triumphant in battles. However, it is not only about the big guns, but also the ability to engage targets in real time with precision. "Firepower India: 2013" will focus on some of these issues.

In the Indian context, the overwhelming dependence on imported weapon systems, missiles and ammunition remains a crippling debility which constrains the armed forces from undertaking sustained operations. As part of the indigenisation process, The Defence Research and Development Organisation (DRDO), the Ordnance Factories Board and the Defence Public Sector Undertakings are the key players in modernizing India's military. But 66 years after independence, India still imports more than 70 percent of defence needs. Therefore, a mission-mode national campaign encompassing private and public sector must be launched with the utmost urgency to attain 60-70 percent self-sufficiency in defence hardware as mandated by the Raksha Mantri.

Theme Address – Air Mshl VK Bhatia, PVSM, AVSM, VrC (Retd), former AOC in C WAC IAF**

The topic “Firepower India” has acquired immense importance for the Indian armed forces in the current and emerging geopolitical realities of India. The focus of the seminar continues to bring together the users and providers to make the armed forces spell out that is need and to expose them to the latest technology to enhance their firepower capabilities.

It is ironic that the firepower seminars are held in a hall named “Ashoka”. Ashoka was considered as one of the greatest emperors of India who in spite of being a successful conqueror renounced violence when he saw human suffering in one of the battles – Battle of Kalinga – he won. Much later in the history of India, it was none other than Mahatma Gandhi who professed the principles of non-violence during the colonial rule. While Gandhi did not suggest that India should be deprived of military powers, some political quarters mistakenly thought that a peace loving India will not have enemies and therefore there was no need of wasting huge precious resources on the country's defence. The 1962 debacle proved how wrong such a political judgment was.

Thereafter, the awakened nation went through a programme to rebuild its armed forces which proved its worth with an astounding victory in the 1971 war against Pakistan. Much later, the Indian armed forces went on to prove its operational capabilities even in the most difficult of terrains with its victory in the Kargil War, 1998.

In the 21st century India with the help of many budding think tank organizations, an event such as this very seminar has helped in understanding the security challenges and helped in addressing the issue of the ways and means to deal with such challenges and shortcomings.

Jihadi terrorism and other such security threats have provided India with a plethora of multiple security challenges. Therefore, India must be prepared for any given situation in security matters, starting right from sub-conventional proxy war to full blown conventional war and if need be, even knocking on the door of nuclear capabilities.

Politically, India plays the role of a soft power, but India also needs to develop adequate deterrence and means to safeguard its safety and sovereignty on all fronts. However, the good news is that all divisions of India's armed forces have embarked upon 15 years perspective planning programme of modernization and capability building encompassing all elements of firepower.

But the fact remains that such programme includes substantial capital outlay in the region of \$ 250-300 million with IAF itself poised to spend 50 percent of the amount. The mantra is comprehensive ISR capabilities including long distance, all reach, all weather precision capabilities. And this, Ladies and Gentlemen, is the theme of this seminar, "Firepower India: 2013."

Among the topics on technology to be discussed, I would like to make a special mention of the EMALS systems installed in the latest US Navy aircraft carrier as the replacement of the steam catapults which may have applicability for the Indian Navy's futuristic 60,000 tons plus indigenous aircraft carrier.

Keynote Address- Lt Gen Narendra Singh, AVSM, SM, VSM, DCOAS (P&S)

- Distinguished delegates, ladies and gentlemen. Predicting the future is a challenging exercise, as crystal gazing is not an exact science. But if one has to put his finger on one single most important facet of any battle-winning factor, then one can confidently say that it is Firepower. To this end, this edition of Firepower India 2013 aimed at assessing the contemporary and emerging

threats and challenges remains ever seminal. It is a matter of privilege for me to deliver the keynote address on one of the most important facet of warfare.

- Rather than dwell on the 'Spectrum of Conflict' and the 'Threat Paradigm', which is constantly evolving and highly unpredictable, I will dwell on the profound impact of technology on battlefield dynamics and method of war fighting. The future battlefield can be visualised to be one of high fluidity with no distinguished front, flanks or rear. Other notable aspects are:

- a) **Accelerated Tempo of War:** The speed of data processing and its dissemination of decision making along with improved sensor to shooter interface will increase the tempo of war tremendously. Warfare will be characterised by highly mobile operations with the tactical scenario changing and threats of operations becoming more extensive. With dwindling reaction time for decision making, the biggest challenge for commanders is to take timely and correct decisions.
- b) **Vanishing Fronts:** Battlefields of future will extend across all dimensions of distance, altitude and time. With the aim to wrest the initiative from the enemy, commanders would aim to strike deep where the enemy is vulnerable, avoiding frontal attack. Weapons on non-contact war would accordingly be increasingly used in future wars.
- c) **Increased Transparency:** Advanced technologies will continue to expand detection ranges, improving quality of information and dissemination data, thus making the battlefields more transparent, fast, fluid, lethal and more dynamic. With improved situational awareness, commanders will be able to coordinate operations of multiple units/subunits and systems seamlessly.
- d) **De-massification:** Mass attacks in terms of soldiers as well as volume of fire will be replaced by massing of effects with surgical precision strikes. The effect achieved by 300 conventional artillery rounds on a target could well be achieved by 30 rounds of improved conventional munitions or just a few rounds of precision guided munitions. This in turn will reduce logistic requirements, making the organisation lighter, thereby improving

operational capabilities. De-massified destruction with surgical precision would also reduce collateral damage without compromising on the mission aims.

- e) **Use of Artificial Intelligence for Decision Making:** The increasing amount of information available from surveillance, reconnaissance and target acquisition systems makes human collation and analysis a near impossible task. Computers are also becoming increasingly capable of taking decisions regarding the choice of appropriate weapons and timing of their launch. This concept has been on the anvil for a long time and on maturing, should ideally generate options for commanders to choose from, based on other operational requirements.
- The game changers on the contemporary battlefield are going to be phenomenal advances in Intelligence, Surveillance, and Reconnaissance technologies, precision guided munitions (PGMs), enhanced firepower and accuracy of various weapon platforms, Advanced Robotics and Unmanned Systems, all being employed across the varied dimensions of war fighting, including Space. Integration and exploitation of these would change the face of battle on the future battlefields. The Americans aptly demonstrated the long-range precision firepower, when they fired Tomahawk Cruise Missiles against Osama bin Laden's camp in Afghanistan and a chemical factory in Sudan. These surgical strikes were carried out from Naval platforms, passed through the medium of air, were guided by space based assets and struck land targets.
 - 4. Manoeuvre and firepower are two sides of the same coin. Are the emerging technologies indicative of shift 'from Victory through Manoeuvre to Annihilation through Attrition?' With the subcontinent's backdrop of a conflict under a nuclear overhang, wars are expected to be short and intense. Can India transform its firepower capabilities to cause major attrition through generation of massive asymmetries of firepower? The long range vectors we have on our inventory, the AGNI and BRAHMOS – would they play a pivotal role in any future conflict?
 - To balance out the ever progressive technologies that are available today and in the future, with the appropriate battle strategies, is essential for all military

commanders. The challenges that lie ahead for our scientists, researchers, strategists, defence industry both public and private, is to be able to harness the emerging technological advances in the field of precision firepower so that the vulnerabilities of our adversaries can be effectively exploited, with longer ranges and consequently lower risks.

- I am sanguine, that the galaxy of delegates present, will dwell on different facets of multi dimensional firepower capabilities that the Armed Forces must seek to ensure a decisive victory over our adversaries when called upon to do so. I wish the Seminar the very best in its endeavour of arriving at pragmatic and implementable solutions.

Inaugural Address – His Excellency Shri Shekhar Dutt , Governor, Chattisgarh

- I am indeed privileged to be inaugurating this important event. The theme that you have chosen is both contextual as well as important. I am very happy to note that in your consideration of firepower, you have planned to discuss the complete spectrum of the three Services. The discussion is not being restricted to land based systems alone. My experience of 1971 operations emphasized that the essential elements of firepower are Reach, Precision, Destructibility and Timings. We can improve on all these only if we start thinking of firepower as a system and structure instead of considering it merely as a means of delivery of explosives.
- I do not wish to pre-empt the various issues that will definitely emerge from your deliberations. I will only set the ball rolling by making a few broad points about the context as also by highlighting a few gaps that you may consider in your deliberations.

Context:

International discussions and debate veer around the fact that the Global Centre of Gravity is shifting to Asia. It is based on a trend that indicates that the Region is becoming economically more attractive as also acquiring more say in global matters. While this may be an encouraging factor, one needs to realise that the Asian region is

also the most strategically unstable. Unlike Europe which has reached strategic stability, Asia is besotted with the uncertainties of change – Asia is a region where contradictions and opposites coexist. Even a cursory examination will reveal that the rising and declining powers are here. The prosperous and failed states coexist. Responsible and emerging powers have to share geographic space with rogue states. Political diversity is also huge. One sees the whole spectrum. It includes democracy, communism, authoritarianism, and even nuanced soft authoritarian regimes. The challenge in this kind of an environment is to get past the legacy of historical differences. Therefore, it is no wonder that the region is a witness to huge military spending and defence allocation. Friction in this kind of setting is unavoidable. Your deliberations are therefore relevant, important and also urgent.

Issues for Debate:

While I was seeing your programme, I noticed that the themes that you have chosen cover nearly all specific competencies that add up to firepower as a holistic capability. It is a laudable concept but I wonder, if aggregation of competence is the ideal methodology to perceive firepower. In my view, the start point for a debate on firepower should be an integrated perspective of what the Indian Military wishes to achieve. Let me explain this a bit further. As we all know, the nation's nuclear deterrent programme has been kept insulated from our conventional capability. This is entirely for very valid reasons and I do not wish to debate it. However, if we were to look at the larger possible war zones and that too in the backdrop of a nuclear overhung, we will realise that our present conventional capability is much short of our requirements.

While we many have the precision and reach in the tactical frame, we lack this capability as far as the overall strategic requirement is concerned. Let me take a specific example. The most vulnerable part of the Tibetan Plateau is its lip where infrastructure is at its weakest and is also the most vulnerable. If these vulnerable logistic lines are interdicted, the adversary cannot develop alternatives in a single campaigning season. This is what shaping the battlefield is all about. For achieving this we will need a range of 1500 Kms. And pinpoint accuracy. Our present capabilities of IAF and Brahmos fall much shorter of our requirements. The problem is that each

Service is looking at its own tactical frame. I only mention this to highlight the fact that gaps get created when we look at only specific competencies instead of our overall requirement. Unless responsibilities and ownership is designated in the larger context of war winning capabilities, such gaps will always emerge.

On this same issue, let me make one more point. If we were to look at our indigenous strength in the array of platforms available for war fighting, one would notice that missile capability is our strength. Yet we do not have structures like 'Second Artillery' to shape or prepare the battlefield based on this indigenous capability. Our doctrine and strategies have not taken this strength into account and therefore, even our development has been fairly restrained despite its potential. We need to consider this potential if we are to strengthen our firepower capabilities.

Precision and Geo Reference System:

Another thought which keeps engaging me is regarding improving precision in our firepower capabilities. Smart munitions of today are based on exactitude of data and their ability to direct themselves towards a designated target. Our limitation is that we have yet to acquire or develop a geo reference system of our own and therefore have to depend on globalised systems available. While this by itself is a vulnerability, the larger problem is the interface between maps and such satellite based systems. Let me explain this further. A map after all represents the imperfect sphere of our earth. In changing a sphere into a flat representation, even geometrically, we have to make some compromises. Errors have to be therefore, accepted. These possible inaccuracies are resolved through benchmarking a position and calculating all other map references from this reference. I find it surprising that despite this known problem, the Services follow different protocols of maps. If the referral system is non-standard, I am not too sure if the precision of our firepower will ever be as accurate as what we have planned.

Approach:

Let me end by making a final point about the improvement in firepower that we are seeking. I notice that we have perceived our firepower improvement as part of our modernization. This approach essentially seeks improved specifications. In my understanding, we have to finally create a structure that can out-cycle the decision loop

of the adversary. It is only through this that we can gain and retain initiative. We therefore, need to consider the change as a part of 'Transformation', instead of 'Modernisation'. Specifically in terms of firepower, it would involve integrated structures that cater for improved communication at all levels, the nomination of an agile authority that can allocate resources as also mechanisms for enmeshing it with the means of detecting, identifying and deducing data of a target. An oversight mechanism to take decisions about the priority of targets and the methodology and means of neutralizing the target will also need to be considered. This would involve various specializations concerned with computation that assist precision and reach. We will also have to consider logistics involved in delivery of effective firepower. Instead of specifications we have to look at systems and structures.

Concluding Remarks:

Let me once again express my gratitude to the organizers of this Seminar for having provided me with an opportunity to speak to such a distinguished audience. I wish all of you a very successful interaction and I am sure that at the end of this seminar we will be able to recommend the method and means to improve our fire power capability.

SESSION I- Future of Firepower

Opening Remarks by the Chairperson – Lt Gen BS Pawar, PVSM, AVSM (Retd), former Commandant, School of Artillery

Firepower has been and will continue to play a very significant role in the future. While firepower played a very significant role in the outcome of battles from the times of Napoleon, its devastating effect has increased with technological development. This is being aptly displayed by the Americans in Afghanistan.

Both firepower and manoeuvre are two different faces of the same coin. One compliments the other. Also firepower has two constituents – the delivery weapon system and the ammunition and both have to develop simultaneously. When one dwells

on the technological development at the military level, we are looking at accuracy, longer range, and lethality – both in weapons system and ammunition.

In ammunition we are looking at smart ammunition, which will be able to bring about one shot one kill. An Unmanned Aerial Combat Vehicle (UCAV) delivering a lethal arsenal on unsuspecting targets operated thousands of miles away would have been unimaginable a few years back. Therefore, one can only imagine what future holds for us in terms of military technology.

Emerging Firepower Capabilities – Maj Gen PR Shankar, VSM, ADG Artillery

When one dwells on firepower, one cannot wish away the firepower of the past. For instance, in World War I, we saw firepower inflicting mass casualties. We also saw the vanishing of firepower that inflicted brutality in World War II. Even the later day's shock and awe factor of the Gulf War is long gone. What lies ahead is firepower with ability to cater to the localized, highly violent tactical conflicts, with wide ranging strategic ramifications, which in turn will have certain implications on certain kinds of firepower capabilities.

For understanding of the paradigm of firepower capabilities, the battle space can be classified into two categories – hybrid battle space and conventional battle space. Hybrid battle space looks at an urbanised, restrained battle space with civilian combatants and unconventional responses. In Hybrid battle space, winning battles also does not represent peace because of which victories remain questionable. Iraq War and Afghanistan conflict is a case in point. If one sees the conflict in the Gulf, this issue is likely to be seen more often.

On the other hand of the spectrum of battle spaces, one can still find conventional battlefields that have not vanished. In the context of India, conventional battlefields cannot be wished away.

Hybrid battle space is understood in terms of its restricted confine, restrained and minimum collateral damage, and refrained use of firepower. In the hybrid battle space, description of key areas and localization is of utmost importance. In the conventional battle space it is just the opposite and it is also characterised by maximum collateral damage, unrestricted employment and widespread destruction in designated areas.

In the sphere of length and breadth of battle space, it has varying demands and varying basis through which firepower is being approached. Increasingly it has been found that the western paradigm of battle space and their perception of threat seem to cater for the hybrid battle spaces. Therefore, when we look at western capabilities, there is a clear line of contraction of firepower resources. Each nation by itself is trying to contract its firepower capabilities and is going in for a collaborative effort so that the sum total of capabilities is available. This is apparently the way ISAF has operated for the past decade and this is how US framed its thought processes in terms of building capabilities.

On the other hand, in Asia, the thought process of building firepower capabilities revolve around the need to cater to the conventional battle space with the ability to reorganize and resize for hybrid battle space and thereby enhance overall capabilities.

Firepower is used as a deterrent that enables gunpoint diplomacy and thereby touches all the three Services. The threat therefore, is more important than application and when applied it should be telling and surgical. Therefore, it clearly emerges that firepower is becoming more and more a diplomatic tool rather than a tool of brutal application on the ground. And this is also the context in which India should develop its capabilities as war avoidance policy has become the order of the day. However, it also has to continue building tools for conventional in case situation demands in the future.

The unchanging characteristics of firepower that are also its fundamentals are – Range, Accuracy, Lethality, Reliability, and Robustness. The emerging characteristic of firepower that goes beyond the realm of flexibility is ‘Agility’. Agility in firepower means agility in platforms and agility achieved as a derivative of logistics and infrastructure. There is also the issue of applicative ability in high tech weapon systems.

Environment and terrain is also a critical element in the building up of firepower capabilities, especially for India. There is also an issue of effect-based application. As most firepower abilities are costly, there has to be an assessment of economy in scales and unit costs and their integration into the planned force structuring.

The issue of simplicity in building firepower capabilities is often overlooked. The quest for having excellent, high tech weapons system may lead to procurement of a system which is not user-friendly and thus does not have the worth of scale.

The firepower mix in a system would comprise 60-70 percent of tube artillery system, 15-25 percent rocket and missiles, and another 15-25 percent aerial manned and unmanned systems. Co-jointly, ranges also spread from operational to tactical depth in a similar manner, with the maximum ammunition being expended at shorter ranges, where the maximum numbers of targets exist. The mix is not negotiable and these weapon systems complement each other, with no single system being able to achieve results on its own. Also, most ammunition at shorter ranges would be dumb ammunition and while precision ammunition may be desirable, they are required in relatively limited numbers.

In terms of the emerging firepower capabilities, the most important is wide spectrum capabilities through multiple platforms and ammunition, which would cater to both hybrid and conventional battle spaces. There is a requirement for standoff capability with calibrated response capabilities, as also deniability capability. In the present times, the tendency is to opt for automated gun systems or delivery systems that give the power of diffused delivery with concentrated effect. The platforms, while being sufficiently dispersed, with autonomous position control, would still provide integrated firepower.

There is a frontal integration of sensors and shooters for both manned and unmanned systems. The manned systems have always been front-end integration of sensors and shooters but what are coming up in the present times are the unmanned system capabilities which have this capability.

In the arena of manoeuvre and firepower, the fundamentals are that manoeuvre can be seen and felt in day to day discussions; firepower can only be felt with targeting. The effect of firepower is critical to the battle. In discussing the emerging firepower capabilities there is also the issue of linearity and simultaneity.

There is a need for integration through net-centrism to multiply firepower. There is a need of elastic communications, synergization with soft kill resources especially space and cyber resources; dedicated and undedicated surveillance sensors with suitable links to shooters. Air space management is going to be critical with the emergence of multiplicity of firepower delivery platforms.

Ballistic Missile Defence: Efficacy, Development, and Employment – Maj Gen H Gopalan, ADG Army Air Defence

Introduction

Threat from ballistic weapons has come a long way since the time Hitler used the V2 rockets in World War-II. The arms race of the 60s and 70s led to the milestone ABM Treaty (Anti Ballistic Missile Treaty) signed in 1972 from which the US withdrew unilaterally in 2002. The quest to achieve a strategic advantage has led to developments in the field of Missile Defence along with the developments in Ballistic Missile Systems.

Missile Defence Systems (MDS) as a concept is defensive in nature and is directed towards restricting the use of firepower. The difficulty in achieving a comprehensive preventive shield against missiles led to the scaled down concept of BMD.

Ballistic Missile Threat

The ballistic missile remains a key element in the military arsenal of several nations around the globe. India faces a multidimensional threat from our immediate and extended neighbourhood.

Threat from Pakistan. Pakistan has stockpiles of proven ballistic missiles, along with the associated launchers and trained personnel necessary to deploy them at short notice. The nexus between Pakistan, China and North Korea in the proliferation of the ballistic missiles in the region has added a new dimension to the ballistic missile threat. The recent induction of NASR, the short range tactical level use missile has far reaching implications. Tactically, it is an offensive weapon meant for 'First Use' in an event of set back at a conventional war. It will present an extremely difficult target to be engaged by BMD system due to its small size and extremely short duration of flight.

Chinese Threat. China has a phenomenal strategic capability with all the three legs of the nuclear triad already in place. Its Ballistic Missiles have inter-continental reach and hence the vulnerability of the Indian subcontinent is complete. The threat continues to grow in reach, range and accuracy.

Nuclearisation of India's Extended Neighbourhood. The proliferation of BMs in India's extended neighbourhood has also grown at a fast pace. The spread of the Ballistic Missile regime around us and the steadily growing missile proliferation in our extended neighbourhood is a cause of serious concern. Countries such as Afghanistan, Iran, Saudi Arabia, Central Asian Republics have ballistic missiles. In West Asia alone there are 6 countries with missiles capable of 2000 kms. And there are 3 countries with missile capability up to 3000 kms.

Threat from Non State Actors There is an increasing possibility of WMD falling in the hand of non state actors. The ballistic missiles would be the preferred vector, due to lack of adequate counter measures against them.

Concept of BMD. Ballistic Missile Defence (BMD) aims to develop the capability to defend the forces and territories of the nation state against all classes and ranges of ballistic missiles. This encompasses:

- Fielding of a BMD system that can address the ballistic missile threat the right time.
- It should be able to detect the launch of enemy ballistic missile(s) and commence tracking using ground based radars.
- Engage and destroy the ballistic missile warhead above/within the earth's atmosphere.

However, it is best to destroy a ballistic missile pre-emptively while destroying its launch platform as well. But the problem here is that the launch platforms are highly mobile and well concealed which makes it difficult for a pre-emptive strike to be successful.

Ballistic missiles are characteristically easy to detect once they are launched. But their hypersonic terminal phase velocity creates a problem for defensive weapons systems. The problem increases in difficulty with the range of missile when its terminal pace increases.

Interception Methodologies. BMD shield would provide engaging the target at various states of its flight. Such system comprises of integrated array of sensors including space based sensors providing a global look capability along with interceptor weapons which can intercept a missile in the boost phase, mid-course and terminal phase.

The interception technologies will be covered under the fwg sub parts :-

- **Boost Phase Interception.** Detecting and tracking is easy as exhaust fumes can be seen from the orbit and hundreds of kilometers in the air. The difficulty is the placement of the intercepting system to acquire a desired outcome.
- **Mid Course Interception.** The most challenging for tracking and detecting because the missile is at the peak of its trajectory and having shed its booster stages, it becomes relatively small in size. Interception also becomes demanding in this phase because of its altitude.
- **Terminal Phase Interception.** It is in this phase that most of the countries are trying to engage ballistic missiles. The heat signature is very prominent, the ionization fumes emits radar signature much larger than itself permitting tracking easier and aligning the war head also becomes easy. The tracking challenges in this phase are the discrimination between the re-entry of the missile itself and the decoys.
- **Space Based Weapons.** The advent of the ASAT weapons took place with the Chinese testing its first ASAT weapon. Space based weapons are aimed at targeting ballistic missiles in the boost phase or in the post-boost phase. The concept gains its validity from the fact that space based sensors provide a global sight and thereby provides larger reach. Space based weapons are highly likely

to come about as a missile defence systems especially after the Chinese successfully tested their ASAT weapon system.

- **Use of DE Weapons.** The trend in BMDs is also moving beyond kinetic capabilities towards directed energy weapons installed in space. The medium could be a laser beam or high powered microwaves. Laser beam weapons have near time engagement of the targets as well as the ability to promptly shift from one target to another.

BMD Systems of some Developed Countries

USA United States has had in development a nationwide antimissile program since the 1990s. It is a tiered system meant to engage incoming ballistic missiles at various stages.

- (a) Lower Tier - PAC-3/MSE, MEADS and Aegis Systems.
- (b) Upper Tier - THAAD.
- (c) Strategic Systems - Midcourse defence system and the ABL system.

Russia The BMD systems of Russia include the following :-

- (a) A-135 ABM system to protect Moscow.
- (b) S-300 PMU1 and PMU2.
- (c) S-300V and S-400.

Israel Israel has a national missile defence against short and medium-range missiles using their Arrow missile system. The Arrow is a family of anti-ballistic missiles designed

to fulfil an Israeli requirement for a theater missile defense system. Apart from Arrow missile, Israel has Iron Dome and the David's sling.

Impact of BMD in the Region

India's BMD Programme: The Indian BMD programme is structured as a two-tiered system with Prithvi Air Defence (PAD) for high altitude interception and Advanced Air Defence (AAD) for low altitude interception. India is also developing the AD-1 and AD-2 missiles for intercepting IRBM class of missiles. A brief overview of India's BMD programme has been talked about in this sub part.

China's BMD Programme: The earliest started their BMD initiative with the Project 640. They surprised the world by successfully testing a direct ascent Anti-Satellite (ASAT) weapon. Recently they tested a ground based midcourse missile interception thereby demonstrating possession of advanced BMD technologies.

Impact on Pakistan Ballistic Missile Programme: It is argued by some that India's BMD system can lead to Pakistan adopting a variety of countermeasures, resulting in qualitative and quantitative enhancement of its ballistic missile capability.

Need for a BMD System for India

In view of the escalatory settings prevalent in our neighbourhood, there is a requirement to deploy a credible high confidence BMD system.

Helicopters in Manoeuvre War: Maj Gen PK Bharali, VSM, ADG Army Avn – Helicopter is an aerial platform while manoeuvre warfare is a basic tenet of all tactics of the army. So, combining both of them is very complex. Starting 23 April 1944, when for the first time a helicopter was used for a military mission to rescue downed pilots from behind enemy lines in Burma, the use of helicopters has continued to increase in the battlefields.

The initial roles were restricted to casualty evacuation and logistics support. However, their vulnerability to ground fire resulted in efforts to build what is known as the armed helicopter. Later on, it was found out that it was a good platform for attacks against enemy positions, further developments on which led to what is known as the attack helicopters.

The ability of helicopters to take off and land vertically, to hover over certain areas and its good slow speed handling characteristics makes it a formidable platform to be employed with manoeuvring ground forces. Further, if these helicopters are mounted with guns, air to air missiles, air to ground missiles, bombs etc. it gives firepower ability to the helicopter. Helicopter is a versatile machine that can also be used as aerial command and control platform.

The helicopter crew that has to operate with the ground forces must have adequate knowledge of land warfare for optimal employment as part of the combined arms team. Continued exposure to land warfare would help them identify with the ground forces. Integration of these assets will also enable unity of command and make such a force extremely responsive. They would follow the same doctrine and operational concepts as being followed by the ground forces.

Most of the manoeuvre battles are fought in the tactical battle area (TBA) where the requirement is application of right quantity of force at the right time for the desired effect. At the same time the forces should be able to effectively disengage and redeploy to suit the ever changing battle lines. Such operations are known as effect based operations (EBO). Use of helicopters in an integrated manner for massing of forces and massing of fire thus contribute to the crux of manoeuvre warfare.

Discussion

- When we dwell on firepower multipliers, there is a need for integration of power of communication and networking.

- India needs to improve on its infrastructure for ease of movement of firepower resources. Enhancing logistics is the need of the hour and there is need for innovative solutions.
- Relevance of helicopter in battlefield cannot be debated. Attack helicopters are a force multiplier and not a flying tank or flying BMP.
- Secure communications between helicopter to helicopter and helicopter to ground are a must for the future battlefield.

Closing Remarks by the Chairperson: Lt Gen BS Pawar, PVSM, AVSM (Retd), former Commandant, School of Artillery – Firepower encompasses delivery of weapons in all the domains including the space. The induction of MMRCA and fifth generation fighters in the Air Force and of under construction/ refurbishment aircraft carrier and nuclear submarines for the Navy underline the aspect of overall firepower synergy that would determine the military strength of a nation. India's move towards ever more indigenisation is a step in the right direction. Progressive change in policies to include private sector will further boost these efforts.

Special Address: Air Mshl SB Deo, AVSM, VM, VSM, DG Air (Ops), IAF – The desire for a precision weapon is as old as warfare itself. Germans have already tried everything in aviation in World War II and we are just learning from them. The German V1 Buzz Bombs, the Kamikaze attacks and use of electronic beams were all tried out to as an effort towards accuracy.

In the Vietnam War, it took the Americans 7 years, 869 sorties and 938 munitions and several lost pilots, before it developed the M117, a laser guided bomb, to destroy the Thanh Hoa Bridge. During the Gulf War, while 8 percent of the weapons systems used were precision guided weapons, their actual effect on the targets was debatable.

The lessons from the war in Kosovo were different as it was fought against a somewhat competent opposition as compared to Iraq and Afghanistan conflicts. There was a different level of asymmetry in Iraq and Afghanistan that was not there in Kosovo. In Kosovo, there was a vast difference between the claims of PGM's effectiveness and the

actual target destruction on ground. This was because there of inherent limitations on the use of smart ammunitions like target recognition, time available for targeting etc. A case study of Kosovo air campaign brought out the reasons for reduced effectiveness of precision bombing campaign against land force targets as:

- Inclement weather during first 47 days of the campaign – most weapons used electro optical sights that required the target to be visible for aiming.
- 50 % cloud cover – more than 70 % time. A similar situation exists in the sub-continent.
- Widely dispersed and well hidden targets
- Enemy AD forced higher release altitudes thus affecting aiming accuracy
- Uncertain battle damage assessment for most missions
- Use of credible decoys by Serbians
- Limited numbers of PGMs available (JDAMs)

The major requirement for precision attacks in the area of target detection includes – all weather capability, inputs from array of sensors such as EM/EO (UAV)/ SAT/ HUMINT, along with assessment of DMPI (Designated Mean Point of Impact) and the best weapon match.

Target identification requires confirmed identity, the assessment of collateral damage and assignment by the designated authority. Geo-location of the PGMs should use multiple sensors like Inertial Navigation/ Global Positioning Systems/ Satellite inputs/ Electro Optical sensors (IN/GPS/SAT/EO). The target imaging should be given in the desired form, with reduced coordinate conversion errors, through a competent inter-services organisation and there should be timely updates for moving and emerging targets.

There has to be an assessment of the AD environment, the available platforms or weapons and the weapon of choice. At the same time there has to be monitoring of change in target characteristics, update on position, change in target defences, effect of strike on target and requirement of revisit.

The future of precision weapons aims at looking into a large standoff range as there will be proliferation of advanced AD weapons system and preserving high value air assets

will take centre stage. Future precision weapons will also be smaller and lighter in size thereby enabling carriage in large numbers to engage multiple and emerging targets with enhanced lethality and agility.

These weapons also have to be affordable for procurement in adequate numbers. The cost of building such weapons has been coming down with proliferation of technology and the buyers should be aware of this.

Precision weapons of the future will have multiple sensors or guidance methods, making it all weather capable. It will be networked to enable control by agencies other than launch aircraft, after launch. Integration of technologies such as anti-jam GPS antenna, MM wave seekers and automatic target recognition will take place in the precision weapons system of the future.

Development of precision weapons today is not a difficult task and we must aspire for self reliance and self sufficiency in making of such weapons and systems.

SESSION II: Synergising Space and Intelligence, Surveillance & Reconnaissance Future of Unmanned Systems – Maj Gen GD Bakshi, SM, VSM (Retd)

Unmanned systems have virtually generated an RMA (Revolution in Military Affairs) in recent times. This revolution is primarily in the field of Unmanned Aerial Vehicles (UAVs), because the air medium affords the greatest autonomy to unmanned systems and the transparency it has generated has enhanced the lethality and precision of air power by many orders of magnitude. There has been a staggering rise in the scale and scope of the employment of UAVs in recent times.

Though the Indian Armed Forces had inducted UAVs some 14 years ago, we have not kept pace with the phenomenal increase in the scale and scope of the UAV revolution. Modern Air Forces, like those of USA and Israel, will by 2030, transit to a 1:1 ratio of manned to unmanned platforms.

Amongst Unmanned Vehicles, UAVs have proliferated most widely because the air medium presents the best environment for supporting the relative autonomy of unmanned systems. The ground environment is more complex and challenging that is why the unmanned marine systems and unmanned ground vehicles have not kept pace

with the UAV revolution. However UGVs have extensively been employed in Iraq and Afghanistan for Explosive Ordnance Proposal and mine clearance roles.

Most large ships have manned helicopters on board, which provide great flexibility. This has in a way, impeded introduction unmanned systems in the navies. The Chinese Navy has acquired 18x Austrian S-100 cam copters and has a pioneer type fixed wing UAV(ASN 209 Silver Hawk). The Pak Navy was carrying out trials of S-100 and may soon induct it.

UAVs have been used for surveillance, direction of artillery fire, designation of targets for fighter aircrafts and Post Strike Damage Assessment. They have majorly been used in asymmetric warfare environments where the level of air defences has been rudimentary or non-existent. The high levels of attrition that they have faced in conventional operations, like in Bosnia, have to be factored in.

In India, they have been used for CI/CT Operations in J&K and the North East.

Few Recommendations:

- Dangerous tasks like SEAD and high value targets must be assigned to unmanned systems
- We must leverage our skills in the software development and field more sophisticated sensor packages on legacy UAVs and employ better algorithms to convert mass data into actionable algorithms.
- UAVs with multi sensor arrays would play a vital role in locating the mechanized reserves of the enemy.
- UGV swarms could be used for deception by generating the signature of own tanks to confuse the enemy and divert/waste his resources in the wrong areas.
- Satellite communications must be exploited to enhance range & flexibility of UAV ops
- Data communication should be rugged, secure, have in built redundancy and must be similar for all three services.

ISR in Maritime Domain: Rear Adm DM Sudan, ACNS (Air), IN

Accurate, actionable, real time information is a prerequisite in the modern conflict. ISR (Intelligence, Surveillance and Reconnaissance) has assumed greater significance as a

means to collecting, processing and analysing information followed by dissemination in a structured manner. A capable ISR organisation would be the key enabler in facilitating delivery of timely and accurate firepower. Nowhere is the need for an effective ISR more required than in the Maritime domain for protection of our interests.

The numerous threats in the Maritime Domain are:

- Terrorism
- Illegal Migration
- Piracy
- Trafficking
- Arms Smuggling

In such an environment if the Commanders are to make informed decisions and achieve operational success, they will need to be provided the most comprehensive information possible in the shortest possible time. The ability to detect, identify and track potential threats and targets over large distances on a continuous basis is essential in the maritime domain.

The continuous process of gathering maritime information, with an aim of enhancing situational awareness, detecting threats that affect the safety and security, economy or environment of a country and enables their successful engagement is called Maritime Domain Awareness. It is a key component of a nation's preparedness and result of layered maritime defence architecture achieved by ability to collect, analyse, display and disseminate actionable information to users. This would entail an ISR system encompassing sensors, hardware, software, analytical tools for analysis and a network for dissemination.

A layered ISR Structure encompasses Space Assets, HALE, AWACS/Maritime Patrolling Aircraft MPAs in a high orbit, MPAs and MALEs in a medium to low orbit, while warships in the area with their organic helicopters, Tactical UAVs, Submarines etc, in the lower area. Land based sensors such as shore radar and DF Chains, intelligence organisations complement platforms at sea and in the air. All sensors have their own characteristics and thus advantages and disadvantages. Maritime aircraft provide the most immediate and reliable information and because of their versatile roles

form the core components of maritime ISR structure. The game changer in recent times has been the induction of the P8I (in the Indian Navy).

There is a requirement to enhance the ISR capability, considering the area involved through MR aircraft supplemented by assets like shore and ship based UAVs.

AIS (Automatic Identification System) and LRIT (Long Range Identification and Tracking) systems are contributing substantially to the maritime surveillance effort.

Networking of all sources of information is an important pre requisite for an effective MDA. Network Centric Operations (NCO) significantly improves ISR quality and is critical enabler of MDA. An efficient information grid can help fuse the information from all available sources and provides the Commanders with a near real time situation awareness. The NCO also provides collaborative mechanism spanning across the agencies within the country to achieve MDA. Efforts are on to establish a national maritime awareness grid steered by the MoD.

The task of providing an efficient ISR Capability for an effective MDA over the IOR is an onerous responsibility which is being pursued by the Navy vigorously. In order to enable increased over all situational awareness in maritime domain, thrust is being provided to significantly improve our ISR capabilities be it in terms of assets, expertise, networks or human expertise.

Precision in Satellites through Pointing, Positioning and Beam Forming – AVM DN Ganesh (Retd), Honeywell

Military Applications of Space could be broken into the following heads:

- Surveillance by Panchromatic, IR, SAR, Multi & Hyper spectral Imaging Sensors
- Electronic Intelligence and analyses of voice and data transmissions
- Communications :Data and Voice
- Controlled Transmission through Beam Forming Networks – Shaping the communication beams to restrict it to the desired area as also making it resilient to jamming
- Air and Land vehicle management by Sky Connect, Osprey Wings, through satellite networks

He talked about Miniature Inertial Measurement Unit (MIMU), Space IFOG IMU, STARMU, produced by Honeywell, highly accurate and robust units that help satellites maintain its position in space. This in turn contributes to accurate ISR inputs from the satellite. The Reaction Wheel Assembly Family, works on the principle of precession and helps control the satellite to point it at the desired place.

The Sky Connect Air Craft Tracking System uses the Iridium constellation and has the following capabilities:

- Tracking of all airborne assets in all types of terrain
- Automated position reporting plus urgent notifications
- Voice calling using dedicated dialler direct to Operation Centres Fast response to hostile action
- Pin Point rescues after shoot downs.

The Osprey main features are as follows

- Worldwide Tracking, messaging and alerting
- Alerts to multiple contacts via SMS and email as well as systems messaging
- Effective for ground as well as air vehicles
- Up to 450 customisable pre defined messages
- Stealth mode for silent and low backlight operations
- Customise views using Points of Interest.

Unmanned Systems – Mr Jim Thomson, Dy Director, General Atomics

The real product that General Atomics deliver is situational awareness, and they use the air vehicles and sensors as a means to achieve that end. The Predator series of aircraft, which includes the original Predator system first flown over Bosnia in 1995, the Predator B or Reaper as the USAF calls it, the Gray Eagle flown by the US Army, the pure jet Predator C Avenger and our newest aircraft, the Predator XP, have accumulated over 2 million flight hours. Over 50 Predator series aircraft are airborne every second of every day worldwide.

The original Predator has been in operation since 1994. Because of its reliability, it was this platform that was chosen to undergo a complete redesign to incorporate advancements when GA-ASI decided to expand its international business pursuits. Predator XP is based on the proven performance and long endurance of the original Predator but it has been updated with all new, triple-redundant avionics, Auto Take-off and Landing Capability which the original Predator does not have and a Lynx wide-area search radar with both overland and maritime mission modes. Even with all of these improvements, we still have an aircraft that can stay aloft for up to 35 hours, and attain altitudes up to 25,000 feet.

Mission Analysis of India by General Atomics is as follows:

- Infrastructure protection
- Population Centres
- Maritime Control
- Border Control

GA-ASI UAS provides long endurance and utilizes multiple payloads to provide the persistent surveillance required to monitor today's threats. The XP system is designed to support all types of surveillance missions including military ISR, border protection and security, maritime surveillance and internal critical infrastructure monitoring.

Discussion

- The Predator has software called STARE for storage, retrieval and exploitation of vast amounts of assorted data. The data can be sorted and retrieved as per differing requirements. In case of loss of data link, the aircraft can retrieve autonomously to base. Data links for control, both LOS and satellite, are encrypted.
- Navy is undertaking trials for Tactical UAVs.
- After the Mumbai attacks, maritime surveillance has become the top most priority with sensors and networks, as mentioned before, having come up to support the overall maritime domain awareness.

Remarks by the Chairperson Maj Gen Dhruv C Katoch, SM,VSM(Retd) , Director
CLAWS

Information load will be the most serious problem in the near future. The timeliness of decisions should not be sacrificed for want of “complete information.”

SESSION III: Reach and Precision Targeting

Precision in Reach – Mr Arijit Ghosh, Honeywell, R. Muralidharan, TATA Power SED
Honeywell has been providing a portfolio for firepower solutions. Government and the armed forces in India have together made efforts towards indigenisation of critical technologies and Honeywell has tried to localise this technology for repair and maintenance of these weapon systems. In this respect, it has tied up with TATA Power SED. The TALIN (Tactical Advanced Land Inertial Navigator) systems incorporated into various platforms have been proven under Indian conditions.

TALIN Summary

- Delivers best value
- Enhances operational efficiency in a battlefield environment
- Provides full 3 D navigation and pointing solution
- Graceful degradation (GPS, VMS, ZUPS)
- High reliability –withstand howitzer and mortar gunfire shock
- Battle proven hardware on many different types of platforms
- Provides common operator training irrespective of platforms
- Logistic support in country

TATA Power SED has been associated with defence related system for about four decades. It has provided launchers for Akash and PINAKA systems in collaboration with DRDO.

The Firing Efficiency & Accuracy depends on

- Slewing Accuracy of the Azimuth and Elevation system
- Optimal selection of the Wire Race slewing bearing, Amplifiers, Motors etc

- Use of INS for achieving Pointing Accuracy
- Target acquisition capabilities
- Ballistic Calculations
- Fire Control Computer System capability

TATA Power SED has collaborated with Honeywell to provide solutions towards this.

He also covered the other projects that the company has undertaken for the Army which included upgrading of L-70s, Zu -23 gun systems and T-90 tanks.

Aircraft Carrier and Continental Reach- Rear Adm Karambir Singh, AVSM, FOC
Maharashtra & Gujarat Area (FOMAG)

Aircraft carrier is a floating airbase and it is as good as the capability of the aircraft it supports. Integral air is essential to any meaningful naval operations. An objective analysis of naval tactics, the geography of our subcontinent and larger strategy irrefutably demonstrates the validity of having tactical air support from a carrier.

Aircraft carriers are potential military instruments that have immeasurable continental reach. They can be employed expeditiously during the initial phases of a crisis with a capability to sustain in the area even in the absence of any host nation support.

India's Maritime Strategy lays out a wide gamut of roles for the Indian Navy. The Navy will be expected to perform operations ranging from "distant credible sea denial over large areas of the Indian Ocean" to "distant sea control in selected areas to protect economic interests and mercantile traffic," to conducting "phased operations" which will result in the use of maritime power to support land or air borne strikes. India's carrier fleet will therefore have to display a high degree of tactical flexibility, which can be accomplished by reconfiguring the vessels air wings depending on the nature of crisis at hand.

Some maritime issues that impact on India's national interests are:

- Globalised World – Interlinked
- 'Flag Follows Trade'
- India's population 1/6th of the world's population
- Economy – Natural Resources, Oil, Food

- Antarctic resources – jostling for resources in the future
- Arctic – Observer Status. Opening up of new SLOCs with global warming.
- Overseas Ventures – Sakhalin, Venezuela
- Irreversible dependency of the global economy on maritime transportation and on free access to sea lines of communication (SLOC)
- Increasing exploitation of seabed resources and alternative energy resources
- Maritime power as opposed to purely military power has Geo Economic Connotations
- Natural Disasters- Earthquake, Tsunami, rising ocean levels, half of the world's population in coastal areas.
- Chinese Assertiveness- should spur India on
- US presence- stabilising but not always permanent
- Political strife- Maldives, Somalia
- Instability/rise in regional fundamentalism leading to violence, breakdown of law and order and religious intolerance- disquiet in large Indian Diaspora
- Net provider of security in IOR
- Mind Space in addition to Land, Sea & Air Space- Hard Power needs to be both credible & scalable, for which the carrier is ideally suited.

Developed, Worked-up & operationally credible carrier capability states how a nation perceives itself and how it wishes to be perceived in the international system.

CTF (Carrier Task Force) features that make it amenable to Continental Reach Ops

- Sustenance/ On station Persistence – two to three months
- Reach & Strategic Mobility – ability to project power at great distances, at a time & place of choosing.
- Flexibility - Air wing could be configured based on the mission.
- Scalability – Surge Capacity
- Op Independence – Min outside support
- No need for Access, Basing Facilities & Over Flight rights
- Credible Force – Fire Power, Lift Capability
- Capability is based on Number, Capability & Sortie Generation Rate of its aircraft
- Advantages of being an advanced mobile airbase:

- Max performance immediately on arrival in the area of ops.
- Limits impact of fatigue, wear and tear of men/ aircraft, due to proximity of targets.
- Flight ops with max safety, being less vulnerable to incursions and terrorist attacks, compared to an airport in a country near the area of crisis.
- Command platform, close to area of conflict or crisis, thus, optimising decision making process and improving flexibility, promptness and effectiveness of the military action.
- Excellent versatility, which allows the decision makers, at a political level, to finely calibrate the diplomatic or military actions in order to optimise the management of a crisis. It also provides the option of varying the military pressure with much greater flexibility compared to the employment of troops on ground.
- Close proximity to theatre enables instant response to rapidly unfolding developments.
- The ability to influence the outcome of a crisis by mere presence in the area.

Likely Continental Reach Scenarios

- Full scale conflict with our adversaries.
- Intervention in support of a friendly govt.
- Deployment to overseas crisis location to diffuse Hot Spots or Potential Conflict Scenarios.
- Intervention in AOI littoral nation in support of national interests leading to rising tensions/ standoff/ conflict situation with our adversaries.
- NCEO to evacuate designated Indian persons from Persian Gulf/ Red Sea.
- HADR ops to assist littorals in the wake of a severe natural or manmade disaster.
- Peacekeeping/ peacemaking ops when mandated by UN (Joint Ops/ Combined Ops).
- LIMO/ MIO against terrorist/ pirates in the AOI.

There are a few conditions that navies have to meet before they acquire carriers. These are leadership endorsement, financial affordability, naval strategy that defines missions and availability of requisite technologies.

The Indian Navy is presently a one carrier Navy. In the coming years however the fleet will be augmented with Vikramaditya, IAC (Vishal) and IAC-2. India has long striven for a three carrier fleet comprising one carrier task force stationed on each seaboard and a third carrier held in reserve.

Some of the things that are envisaged by me in the future for the Navy are:

- CATOBAR (Catapult Launch) – EMALS & Ski Jump – (with improved relations with US)
- Future Proofing for future aircraft
- Size (75 - 80,000 tonnes) – 60 + Aircraft
- Nuclear Propulsion – Endurance & Speed improvement
- Sortie Generation Rate – 160/ day
- UCLASS – Unmanned Carrier Launched Surveillance System – X-47B (UCAV)
- Modularity - Joint Ops with Army & IAF
- Combined Ops with cooperating navies
- Retain focus on Strike Role – Remove ASW helicopters to other ships of the fleet

Missile Development & Precision Guidance – Dr Vivek Lall, President and Chief Executive Officer, Chairman's Office, Reliance Industries Limited (TBC)

For a country which is a nuclear power there has to be a credible missile based system. According to the strategists the warfare in future will be heavily dependent on the missiles. Ballistic missiles remain a central element in military arsenals of nations. Countries devote scarce resources to build up ballistic missiles and build the infrastructure to sustain future production. Countries look at world markets to compensate for domestic shortfalls.

Emerging ballistic missile states continue to increase the range, reliability and accuracy of missiles in their arsenals. Proliferation of technology, materials and expertise has enabled nations to upgrade their ballistic missile programmes.

Similarly, advances in guided missile development have enabled missiles to supplement the gun as the primary air to air weapon. Medium and long range radar guided missiles have enabled Beyond Visual Range (BVR) engagements.

Missile development has to be planned with concurrent development of successive generation of fighter aircraft. Technological developments in aerodynamics, propulsion, materials and electronics have enabled advances in fighter capabilities. Currently global market is dominated by 4th generation aircraft; however its increasing costs is a major challenge faced by several nations. Efficacy can be maintained by reducing the speed of the aircraft and focus should instead lie in improving weapon systems. In the context of 6th generation fighter, we can assume that it will have Directed Energy Weapons (DEWs) and high powered microwave and laser defensive and offensive weapons.

Several countries are going for hypersonic cruise missiles, progressing up to Mach 7. Accelerating at hypersonic speed involve complex aerodynamic processes and complex multimode propulsion systems. Such technological advances would also enable building of more advanced cruise missiles as also to develop new generation of launch vehicles. Also Sub orbital aircraft and possibly main space planes capable of reaching orbit after horizontal take off from runways.

Accuracy and sensitivity is fundamental for the missile to converge on its target and to discriminate and foil enemy countermeasures and decoys. Significant progress has been made to create agility and manoeuvre control of these missiles. Flight Control System (FCS) is the key element that allows the missile to meet its stated performance objectives. The type of steering command would vary depending on the phase of flight and type of interception. For low level flights of missiles, advanced algorithms and state of the art computer hardware offer major opportunities to enhance missile capabilities. There is a significant progress in agility and manoeuvrability of missiles by augmenting aerodynamic forces with thrust vectoring.

At the macro level, there is huge scope for governments to work on collaborative programmes to develop technologies to enhance countries' military capability.

Security of missiles is a big issue as a number of governments, including unstable regimes, are expanding their missile arsenals and are pursuing nuclear technologies.

Futuristic Aircraft Carrier – Mr Scott Forney, Senior Vice President, General Atomics,USA

General Atomics has had a consistent history of delivering transformational technologies and exceeding customer expectations.

EMALS (Electromagnetic Aircraft Launch System) technology deals with catapult systems to launch aircraft from carriers. This system gives ability to launch bigger aircraft that would have more endurance and more payload capacity. The change from steam to electric system is to get more capability from the system. It uses the ship's electric grid to charge its 12 electrical motor generators. The next generation of Indian aircraft carriers will be large enough to hold two catapults.

EMALs can also launch very small aircraft such as the UAVs. EMALs program advantages are:

- Better Control of Applied Forces
- Reduced Manning
- Improved Reliability and Maintainability
- Improved Operational Availability
- Reduced Thermal Signature of the Ship
- Lower operating cost over the life of the system
- Can be fitted in existing spaces

It has completed 134 launches across five classes of airplanes culminating in the launch of an F-35 C Joint Strike Fighter. At present, its system requirements validation is in process and environmental qualification tests are continuing.

The AAG (Advanced Arrestor Gear) Program Objectives are to deploy an advanced arresting gear system that provides similar advantages as EMALS. Its environmental qualification testing is ongoing.

Discussion

- EMALS catapult will not deliver till 2015.
- The equipment does not need nuclear power propulsion to produce sufficient power for charging up the motors.
- Weapons and not aircraft will hold the key to sixth generation technology.
- The British have coined a term CEPP Carrier Enabled Powered Protection that will enable choice of agility operationally and political choice as far as the nation is concerned.

Remarks by the Chairperson Vice Adm Anup Singh, AVSM, NM (Retd), Former FOC in C ENC

This seminar clearly collates various critical technologies in weapon systems and makes one travel through various legacy to futuristic systems. It shows what is available and in store for the Indian armed forces. Aircraft carriers , for example are not only source of national power but the best instrument for se control or carrying out an offensive. We have come a long way from first jet missile to cruise missile, but the basic technology remains the same.

Concluding Remarks- Air Mshl Ashok Goel (Retd)

The objective of this seminar has been to create awareness amongst the armed forces and enhance strategic thinking in the quest of war. In future, it remains to see the effect of technology on the war front and in ensuring peace and deterrence. So far, advanced

technology has caused only pain and bleeding for the humankind, the effects of which are visible in Afghanistan and Iraq of today.

Therefore, technology should be applied to avoid violence, which involves a change of mindset in operating these weapon systems with the utmost responsibility. Five countries have captured the whole market for weapon systems, thereby raising the costs involved in buying them. Affordability is very important in the Indian context and indigenisation of weapon systems should be given the top most priority.

Valedictory Address – Air Mshl M Matheshwaran, AVSM, VM, DCIDS PP & FD, HQ IDS

The Firepower Seminar is an interesting opportunity for the members of the armed forces to be exposed to the current thought processes and industrial development in the arena of weapon systems.

Firepower in the military context is about the application of force on its adversary to achieve the desired victory. Kenneth Waltz, the father of “Structural Theory of International System” said that the anarchic structure of the international system has a flaw in that no nation accepts the superiority of other nation, and looks at its national interests with utmost priority. Hence, conflicts will continue. However, nuclear proliferation has reduced the possibility of conventional warfare and at the same time has fostered deterrence and stability in the world.

In spite of the nuclear capabilities in the region, Kargil war has proven that there is still space for conventional war. Dissatisfied and weaker states, like Pakistan, which do not identify with the peaceful international norms, often indulge in undeclared low intensity conflicts. To counter this, it is advisable to take the route of PGMs, information dominance, effective command and control and the ability to take strategic decisions and to see them through.

Man has always worked to increase the destructive power of firepower. Since the 90s, precision weapons are no longer ballistic but are guided. Major victories have always

been achieved when firepower and manoeuvre have worked in concert. Airpower has the ability to provide both to attack the enemy's Centres of Gravity.

In a country like India where resources are few, it is imperative to look at requirements and perspective planning in coherence with joint operation philosophy. We have come a long way from the conventional processes, concepts and technologies and there is an immense need to exercise control over critical technologies. If the nation depends on import of weapons, then freedom to exploit what we have is limited. A deliberate national strategy is required towards attaining self-sustainability in weapon systems.

Vote of Thanks

It has been a pleasure for CLAWS to have organised this seminar along with India Strategic. The positive response year after year inspires us to continue with this annual event. We would be forwarding a report with pertinent points to the relevant authorities for their consideration.