Seminar Report

Year of Technology Absorption : Empowering the Soldier

24 April 2024 | Manekshaw Centre New Delhi

SEMINAR REPORT

YEAR OF TECHNOLOGY ABSORPTION: EMPOWERING THE SOLIDER HELD ON 24 APRIL 2024 AT MANEKSHAW CENTRE

Welcome Address

1. The Director General, Centre for Land Warfare Studies (CLAWS), **Lt Gen Dushyant Singh, PVSM, AVSM (Retd)**, delivered the welcome address for the seminar. Highlights of his address are given below:-

- Total global defence spending in recent times reached a record level of 2.4 trillion dollars. USA and China account for 50% of this expenditure.

- Countries like Russia, Japan, Taiwan, and India have also increased their defence budget significantly.

- There is an upward trend of spending on research and development of niche technologies for warfare.

- India requires to focus on emerging technologies such as artificial intelligence, machine learning, quantum computing, cyber, space, and unmanned systems to match steps with the rest.

- Traditional warfare concepts in present times are evolving and breaking into cyber, space, information, and cognitive domains.

- Technological progress has reshaped warfare, making it asymmetric and blurring the boundaries between war and peace. Technology has become indispensable for conducting effective warfare.

- The conflict between Armenia, Azerbaijan, Russia, Ukraine, Israel, and Hamas illustrates the critical role of technology in modern warfare.

- Warfare in present times demands a whole of national approach and not just military involvement.

- The private sector plays a significant role in providing technological capabilities for military readiness of a nation.

- To maintain readiness, militaries must be technologically proficient, capitalise on present-day technologies, and prepare for future innovations.

Inaugural Address

2. The inaugural address for the seminar was delivered by **Gen Manoj Pande, PVSM, AVSM, VSM, ADC, Chief of the Army Staff, Indian Army**. The critical points of his speech, focussing on the issue of empowering the solider through the absorption of technology, are as follows:-

- Technology is central to contemporary endeavours across various fields.

- Military technology has evolved significantly over centuries, and has profoundly impacted the warfare. Examples include advancements from rifles and telegraphs to niche technologies like AI and quantum computing.

- Armies adopting and integrating modern technologies gain battlefield advantage and success. However, technology's tactical advantage can diminish without strategic integration. Modern conflicts highlight the transformative role of disruptive and dual-use technologies in conduct of warfare. The lethality and accuracy of kinetic instruments has increased manifold in recent times.

- Emerging critical technologies like AI, quantum computing, robotics, and nanotechnology at present are also accessible to non-state actors which has added a new dimension to the warfare.

- Technology today has become a strategic arena of competition, driving geopolitical power dynamics.

- Disruptive technologies are transforming the character of modern wars and challenging traditional force multipliers.

- Lessons from the recent conflicts show that self-reliance in warfighting platforms and critical technologies through indigenous research and development (R&D) is a must for any nation to survive in future conflicts.

- India is emphasising harnessing indigenous competencies and capacities for defence needs.

- Technology infusion requires innovation, absorption, and adaptation. Building an effective defence industrial ecosystem is crucial for self-reliance for a nation.

- The Indian Army is committed to developing its capabilities through modernisation and technology infusion.

- Emphasis is placed on incorporating modern technologies into existing systems for interoperability and compatibility.

- Training syllabi are being modified to align with future technological requirements, and soldiers are encouraged to take ownership of technology and innovate.

- Cognitive skills development and leadership training are essential to keep up with the future technology-enabled environment.

- India aims to synergise the stakeholders to enhance national security and self-reliance.

- Policy measures, resource allocation, investment, skilling, and incentivising innovation are crucial for fostering a culture of self-reliance.

- The Indian Army is committed to transitioning into a modern, agile, adaptive, and technology-enabled force.

Keynote Address

3. The keynote address for the seminar was delivered **by Dr Chitan Vaishnav, Director, Atal Innovation Mission, Niti Aayog, Government of India**. The salient points of his address are as follows:-

- The Defence Ministry of India is leading technology integration into various sectors.

- Programs like IDEX (Innovation for Defence Excellence) engage startups and MSMEs are being given impetus to address challenges in defence related technologies.

- India over a period has developed a vibrant innovation and entrepreneurship ecosystem, focusing on startups and incubators.

- Atal Innovation Labs in schools and college incubators are supporting innovation and problem-solving. Examples include students developing carbon monoxide sensors, automated chemical mixing drums, and personalised electric fences.

- These innovations address local problems and demonstrate the potential of young innovators nationwide.

- India has over 1,24,000 registered startups, emphasising innovation-driven small businesses. Such startups create jobs and contribute to overall economic growth of the country.

- While startups can address minor, articulated problems, critical problems with no available solutions remain unresolved. Overcoming fundamental constraints requires radical innovation.

- Extreme creativity can coexist with discipline, as seen in examples like Schindler Elevator's innovation initiatives. The armed forces, including the Indian Army, have the potential for radical innovation.

- Radical innovation involves overcoming fundamental constraints rather than just adjusting input variables. Examples like the transition from manual telephony to automated systems demonstrate radical innovation.

- Deep tech involves creating new knowledge and technologies to address fundamental constraints.

- The entire innovation ecosystem, including programs like IDEX, contributes to profound tech innovation.

Session I: Contemporary Technology and Industry Capability

4. The opening remarks for the session were given by **Lt Gen Vineet Gaur, AVSM, DG CD**. The remarks are summarised below:-

- During British rule, India had limited defence manufacturing capabilities and continued its reliance on foreign designs post-independence.

- The defence sector expanded significantly by establishing ordnance factories, PSUs, DPSUs, and DRDO labs.

- Despite overall growth, India remained heavily dependent on defence imports, ranking among the most significant arms importers globally.

- Liberalisation led to policy changes allowing increased FDI in defence, focusing on promoting indigenous design and manufacturing. Discussions around private sector involvement intensified around 2011-12, culminating in policies like 'Buy Indian-IDDM' to prioritise domestic procurement.

- Current trends show increased private sector contracts and a strategic push for indigenisation in defence procurement to reduce dependence on foreign technology.

- A sizeable portion of the defence budget is allocated to domestic spending, focusing on supporting startups and private enterprises.

- Ambitious targets are being set for defence exports and production. Exports have grown significantly, though production targets have seen moderate growth.

- Contracts worth crores are in place, with a robust pipeline for defence contracts and a shift towards faster, decentralised procurement processes.

- The Army Design Bureau plays a crucial role in fostering innovation, with numerous problem statements issued to address capability voids.

- Various initiatives and challenges encourage the development of innovative solutions for enhancing defence capabilities.

- Substantial budgets are allocated for defence capabilities across all branches, with expected increases reflecting opportunities for defence sector players.

- India's defence exports have grown significantly, indicating rising global demand for domestically produced defence products.

- There is an emphasis on developing niche technologies for strategic advantage, advocating quantum leaps in innovation.

- Collaboration with academic and research institutions is crucial for developing cutting-edge defence technologies and ensuring India's technological superiority.

Speaker Presentations

5. The first speaker was **Mr Mahesh Godi, Founder and CEO of Godi Pvt Ltd**. His remarks on advanced Li-ion batteries and supercapacitors for military applications are as follows:-

- The speaker emphasised the importance of energy security, particularly in strategic sectors, highlighting India's need for further development.

- The company specialises in advanced battery technologies like lithium and sodium-ion cells, which are crucial for applications in land, air, and water domains. Godi Pvt Ltd focuses on developing indigenous technologies with input from international experts and attracts talent back to India.

- The company designs battery solutions for defence applications, catering for extreme conditions and specific needs like high energy and power density.

- It emphasis on eco-friendly manufacturing processes and safer battery technologies that maintain performance in harsh conditions without compromising safety.

- It is contemplating to establish a 'Defence Gigafactory' in India to meet the growing demand for batteries in defence and other strategic sectors, with plans to serve international markets.

- The company employs many PhDs holders and holds numerous patents, highlighting its commitment to innovation and quality.

- Godi Pvt Ltd aims to manufacture cost-effective products without compromising quality, focusing on sustainability and economic viability.

- In future, the company strongly looks forward towards expanding its domestic and international presence through collaborations to enhance technological capabilities and market reach.

6. The second speaker was **Rajiv Mehrotra, Chairman and Managing Director of Shyam Telecom Ltd**. His remarks on Visualising Network Centric Warfare-Integrating Cutting Edge Communication and Intelligence Technologies to Empower the Solider and Enhance Combat Effectiveness are as follows:-

- The company's surveillance system stands out for its ability to detect individuals even when conventional technologies, such as radar, thermal imaging, and regular cameras, fail.

- The speaker stressed on the importance of innovative solutions over traditional approaches, especially in challenging conflict zones like Russia-Ukraine and Israel-Hamas.

- The focus is on deviating from conventional military technologies to develop unique solutions that provide strategic advantages, akin to "playing hockey in a soccer match."

- During his presentation, the speaker traced the evolution of wireless technology from its military origins to widespread civilian use, highlighting significant investment increases in mobile technology development from 2G to 5G and beyond.

- The speaker stated that his company designs and manufactures all its technology in-house, ensuring control over intellectual property and customisation to meet specific operational needs.

- Their systems boast of advanced mobile communication technologies, cost-effectiveness, and suitability for deployment in challenging environments like forests, high altitudes, and deserts. Additionally, the systems include health monitoring features for personnel, enhancing force preservation and operational efficiency.

- The overarching theme emphasised achieving operational superiority and force preservation through innovative technology solutions tailored to specific military needs and environments.

7. The third speaker of the session was **Mr Vaibhav Gupta, Director, MKU Ltd**. His remarks are as follows:-

- MKU operates globally, providing products to 230 forces in 100 countries, focusing on homeland and defence operations.

- The company holds over 20 international patents and employs over 700 people, regarded as internal heroes for their innovation.

- MKU emphasises on observation, lethality, communication, survivability, mobility, and sustainability in product designs, particularly body armour and helmets.

- Their design philosophy incorporates functionality, technology, and design, particularly in body armour systems to meet operational needs while managing soldier's physical load.

- MKU addresses ergonomic and ruggedness challenges in current body armour systems by developing new designs that prioritise weight distribution, quick-release mechanisms, and integration with gear.

- The company acknowledges the need for body armour that fits female soldiers properly and has designed specific armour tailored to their unique body shapes and needs.

- MKU's newly launched helmet provides unprecedented protection against rifle rounds and features a bolt-free design for safety, comfort, and 360-degree protection.

- Borrowing technology from sports helmets, the new helmets include a sophisticated suspension system tailored for military use, improving shock absorption and wearability.

- The company has developed multi-sensor systems integrating a ballistic computer, thermal sight, and laser range finder, enhancing accuracy and intelligence for area weapons.

- New advancements include image intensification of weapon sights with Generation C technology, offering high-resolution observation and targeting capabilities.

- MKU has developed night vision systems for vehicle drivers and aviation use, addressing previous reliance on imports and supporting local production and technological self-reliance.

- The company collaborates with local partners to develop night vision systems for mechanised infantry, featuring advanced sensor fusion technology for enhanced visibility and targeting.

8. The fourth speaker for the session was **Mr Nishant Khatri, Representative of FC Tecnrgy**. His remarks on the Energy Empowerment of the Future Solider are as follows:

- Soldiers face burdensome loads due to electronic equipment, relying heavily on batteries, which limits their operational endurance and effectiveness, especially in remote or hostile environments.

- Existing power sources like batteries are inadequate for field conditions, particularly in extreme environments with limited or no recharging options.

- FC Tecnrgy specialises in fuel cell and sustainable technology. Developing and deploying fuel cells aims to reduce the Armed Forces' reliance on diesel.

- The company has developed a nano-table fuel cell-based battery charger that operates independently of weather conditions, using methanol with a low freezing point suitable for harsh climates.

- Fuel cells offer continuous and reliable power, are easily transported, and have a lower environmental impact than traditional power sources. They are weather-independent and suitable for all terrains.

- FC Tecnrgy has successfully executed contracts and trials with the Indian Army, leading to the adoption of its fuel cell technology for field operations.

- In addition to military applications, FC Tecnrgy explores critical sectors like homeland security, railways, and smart cities for its power solutions.

- The company's efforts contribute to enhancing the operational capabilities of the Indian Armed Forces while advancing sustainable technology in defence applications.

Session Outcomes

9. The session underscored the challenges and opportunities in empowering soldiers through technology absorption. The outcomes from the session are as follows:

- There is a heavy dependence on defence imports despite sector growth.
- There is a need to increase private sector contracts and focus strategically on indigenisation to reduce foreign dependency.

- A significant defence budget must be allocated towards domestic spending to support startups and private enterprises.

- Ambitious targets for defence exports and production must be set, with notable export growth.

- Robust pipeline for defence contracts, decentralised procurement processes, and conclusion of majority contracts within delegated powers is a must.

- Various initiatives and challenges have encouraged development of innovative solutions for defence capabilities.

- Collaboration with academic and research institutions is crucial for developing innovative defence technologies.

- The importance of energy security is highlighted, particularly in strategic sectors, emphasising the need for further development.

Session II: Empowering Soldiers: Amplifying Impact Through Modern Technologies

10. The session's opening remarks were given by **Lt Gen (Dr) Subrata Saha, PVSM, UYSM, YSM, VSM (Retd), Member of the National Security Advisory Board**.

11. His remarks are summarised below:

- It is crucial to consolidate demands for technology in defence to avoid redundancy across different forums.

- Requirement for refining combat needs by collaborating with operational and strategic experts to anticipate future battlefield requirements.

- Need for developing and testing concepts to translate strategic ideas into actionable plans, incorporating capabilities and innovations.

- Emphasis required on encouraging innovation in defence technology and collaborating with academia and industry to capitalise on advancements.

- There are Concerns about the ageing workforce within DRDO and other defence sectors, highlighting potential agility issues with rapidly advancing technologies.

- Urgent need for DRDO to focus on developing core technologies rather than complete systems, he suggested complete overhaul of DRDO and learn from experience.

- Emphasised for modernising procurement strategies to match the speed and complexity of modern technology to integrate and utilise advanced technologies effectively.

- Proposal to create a new role within the army to foster technological expertise and innovation among younger, technologically inclined officers.

- Suggestion for officers identified for their technological prowess to pursue specialised degrees and career pathways focused on defence technology advancements.

- Emphasis on embracing current scientific advancements and integrating them into defence strategies to leverage modern military applications.

Presentations by Speakers

12. The first speaker of this session was **Major Gen Sunit Mehrotra, ADG Signals Dte**.

13. His remarks on advancement in military communication systems are as follows:-

- Integrating communication networks across military services enhances coordination and resource sharing.

- Adoption of emerging technologies like 5G, 6G, Quantum Cryptography, Blockchain, and Lower orbit satellites for improved military communications.

- Consideration for technologies like E-band radio and free-space optics for high-speed data transfer and secure military communications.

- Widespread use of cloud solutions, software-defined radio (SDR), and inline network security for adaptable communication frequencies and secure data handling.

- Advancements in power solutions and protective measures ensure the uninterrupted operation of military communication devices in various weather conditions.

- Implementing embedded app encryption enables secure information sharing across military networks, potentially handling classified information securely.

- Use of AI applications to enhance operational capabilities and exploiting serverless computing to improve the efficiency and scalability of military communication systems.

- Focus on SDRs for flexible use of radio spectrums and enhanced secure communication capabilities in tactical environments.

- The evolution of military networks incorporates modern technologies to provide robust terrestrial communication with large bandwidth and connectivity in remote areas.

- Integration of drones, expansion of ISR capabilities, and facilitation of plug-and-play integration for ISR devices through logical separation and firewall use.

- Innovations like spatial audio in mobile phones enhance immersive experiences and sound directionality.

- There are ongoing projects in quantum key distribution, post-quantum cryptography, free space optics, VR tools, and holographic technologies for operation planning and training.

- Integration of commercial technologies like Jio's VR headset demonstrates high bandwidth capabilities and immersive viewing experiences.

14. The second speaker was **Shri JK Bhargava, Scientist G, DRDO**. His remarks on Decision Support System for the Army are as follows:-

- He emphasised on importance of decision support in battlefield decisions, acquisition strategies, and organisational restructuring for enhanced efficiency.

- Modelling and simulation significantly aids decision-making processes by providing a theoretical framework to test various scenarios and outcomes before implementation.

- Specific decision support tools and systems incorporating software technology, system analysis, modelling, and simulation are being developed to assist decision-making processes.

- The effectiveness of decision support systems depends on their integration with operational tactics and the army's knowledge base to ensure practical applicability.

- War games have evolved to include decision-support features, but transition from training tools to decision-support systems requires customisation.

- Effective decision support systems requires comprehensive models encompassing environmental, behavioural, and operational factors etc.

- Rigorous validation processes are necessary to ensure the reliability and trustworthiness of decision support system models.

- Areas such as cyber warfare, net-centric warfare, information warfare, and space warfare are identified for future development of modelling and simulation applications.

- Institutional challenges include the need for a centralised repository of data and tools, formal mechanisms for model validation, and integration among different military branches.

- There is a transition towards AI-based models to decentralise decision-making processes and empower individual soldiers.

- Strategies and models need updating to reflect changes from low-intensity warfare to more complex scenarios, such as grey zone conflicts.

- Resistance to reform within deep state structures can hinder the implementation of new technologies and methodologies.

- There is a discussion about whether AI processing should be centralised or distributed to the edges of the battlefield, leaning towards a hybrid approach.

- There is a shift from rules-based approach towards AI-driven decision-making processes, with the senior military commanders deriving courses of action from wargaming models. He also highlighted the need to establish a National War Centre.

Outcome of the Session

15. The session underscored the challenges and opportunities in amplifying modern technologies' impact on today's soldiers. The session outcome is as follows:-

- Emphasis on the importance of consolidating demands for technology in defence across different forums to avoid redundancy and streamline resource allocation effectively.

- Requirement for a Call for refining combat needs through collaboration with operational and strategic experts to anticipate future battlefield requirements and ensure alignment with technological advancements.

- Need for developing and testing concepts to translate strategic ideas into actionable plans, incorporating capabilities and innovations to enhance military effectiveness.

- Emphasis on the need to encourage innovation in defence technology through collaboration with academia and industry to capitalise on advancements and drive progress in military capabilities.

- Address concerns about the ageing workforce within defence research and development sectors, highlight potential agility issues with rapidly advancing technologies, and propose rejuvenation strategies.

- Propose modernising procurement strategies to match the speed and complexity of modern technology, facilitating the effective integration and utilisation of advanced technologies in defence operations.

- Suggest creating new roles within the Army to foster technological expertise and innovation among younger, technologically inclined officers and ensure a continuous talent pipeline.

- Enable officers identified for their technological prowess to pursue specialised degrees and career pathways focused on defence technology advancements, enhancing expertise and contributions.

- Emphasise integrating current scientific advancements into defence strategies to leverage modern military applications effectively and maintain technological superiority.

- Highlighting the benefits of integrating communication networks across military services for enhanced coordination, resource sharing, and efficiency in defence operations.

- Advocate for adopting emerging technologies like 5G, quantum cryptography, and free-space optics to improve military communications capabilities and security.

- Stress on the importance of utilising decision support systems in battlefield decisions, acquisition strategies, and organisational restructuring to enhance efficiency and effectiveness.

- Ensure the development of comprehensive models for decision support systems, encompassing environmental, behavioural, and operational factors for reliable and practical applicability.

- Address institutional challenges such as the need for centralised data repositories, formal model validation mechanisms, and integration among different military branches to facilitate effective decision-making.

- Encourage the transition towards AI-based models to decentralise decision-making processes and empower individual soldiers, enhancing adaptability and responsiveness in military operations.

Session III: Maximising Technology Effectiveness and Solider Preparedness.

16. The opening remarks for the session were given by **Lt Gen PR Shankar, PVSM, AVSM, VSM (Retd), and former DG Arty**. His comments are summarised below:-

- Key technologies of this century include quantum computing, AI, cyber, communication/networking, space, additive manufacturing, semiconductors, battlefield energy, synthetic biology, cloud memory, engines/propulsions, control & guidance, robotics, and unmanned systems.

- There is a need to expand the scope of these technologies and convert them into weapon systems to enhance military capabilities.

- Technologies must be combined and enabled for battlefield use across various domains, such as battlefield transparency, reach, precision, networks, battlefield energy, mobility, and survivability.

- A vision is required to integrate and utilise advanced technologies in future warfare scenarios.

- Recent opinions from Russian and Ukrainian generals highlight the unique features of today's battlespace, including the dominance of algorithms, the absence of the fog of war, the importance of air defence over military

aviation, and the need for superior artillery and radical rearmament. Additionally, the emphasis is on small and cheap weapons in hybrid warfare scenarios.

- Hybrid warfare is expected to become the new normal, emphasising UAVs, rockets and missiles, digital and space technologies, and nuclear capabilities.

- The effectiveness of technology in battle is not solely determined by its latest status but rather by its ability to win battles. Ownership of technology, regardless of its cost, is crucial for effectiveness. Technology upgradation is essential, necessitating a national strategy encompassing original research, upgradation, import substitution, and alternate methods for military technology.

17. The first speaker was **Lt Gen Rajesh Pant (Retd), Former National Cybersecurity Coordinator, PMO**. His remarks on making the solider cyber resilient are as follows:-

- The topic discussed is timely due to the recent reorganisation of forces by our Northern Adversary, particularly the establishment of information and cyber forces.

- The concept of resilience is emphasised, acknowledging the inevitability of cyber-attacks and the importance of being prepared to withstand them.

- Three fundamental truths about cyber threats are, perpetual nature of vulnerabilities, cyber-attacks and the difficulty of attributing their source.

- Soldiers must comprehend the nature of cyber threats they face across various domains, including weapon systems, equipment, cognitive domain, and physical threats. Examples of threats, such as logic bombs on weapon systems, ransomware attacks on equipment, and DDoS attacks on surveillance equipment, are provided.

- A significant concern today is the susceptibility of IoT devices to attacks, mainly due to inadequate testing during procurement.

- The Ministry of Telecommunication directive in April to test existing surveillance cameras for security features is highlighted, reflecting governmental efforts to address cybersecurity concerns.

- The establishment of a National Trust Lab to evaluate imported IoT devices for security breaches is mentioned as a measure to mitigate threats.

- Disinformation through social media and cybertronics domain threats are identified as risks that soldiers should be aware of.

- The solution proposed involves a combination of People, Processes, Technologies, and Cooperation (PPTC), emphasising education, standard

operating procedures, technological testing, and collaboration to mitigate cyber threats effectively.

18. The second speaker was **Mr Geo George Philip, VP Big Bang Boom Solutions Pvt Ltd**. His remarks on operating in a drone-dominated area are as follows:

- Various categories of drones pose threats, including pseudo satellites, high- and medium-altitude drones, loitering munitions, commercially available drones, and swarm drones.

- Success in drone warfare is attributed to the availability of drones and counter-drone systems, enabling tactical adaptability.

- Tactical drones and portable anti-drone systems at the platoon level are crucial.

- Anti-drone solutions based on scenarios, such as protecting bases, artillery units, soldiers, and armoured vehicles.

- Requirement of integrated air-defence systems with long-range jamming, EO/IR, radar, lasers, and anti-aircraft guns for protecting HQs and bases.

- Vitality of Mobile integrated air defence systems for protecting artillery units.

- Portable/handheld anti-drone systems and autonomous counter-drone "hunters" are essential for soldier protection.

- Active Protection Systems (APS) and Autonomous Visual Situational Awareness systems are considered for armoured vehicles.

- Stealth, cover, and dispersion techniques are to be used to minimise vulnerabilities.

- Operating at night, minimising radio footprint, and using passive RF detection are recommended.

- Deception tactics include decoy drone transmitters and mimicking helicopters and larger aerial vehicles.

- Agility involves changing positions after jamming to reduce the threat of RF seeker drones.

- Versatility is achieved through cheap tactical or commercially available drones with swappable payloads.

- Soldiers need to identify drones and understand their capabilities.

- Training in drone assembly, troubleshooting, and counter-drone tracking using portable passive detectors and jammers is crucial.

- Soldiers must know tactics, techniques, and procedures for counter-drone operations, kill chains, and battlefield protocols.

19. The third speaker of the session was **Dr K Mohanavelu, Scientist, DRDO**. His remarks on human augmentation and solider performance are as follows:

- DEBEL is an interdisciplinary defence bioengineering lab that enhances soldiers' capabilities and combat support in air, land, and water.

- Key focus areas include life support systems, wearable sensors, military exoskeletons, space technologies, NBC (Nuclear, Biological, Chemical) technologies, and strategic and crew protection.

- DEBEL's unique capabilities in aeromedical, biomedical, and underwater technologies at present are also benefitting society.

- Exoskeletons are robotic, mechanical frames worn by individuals to provide additional strength and durability.

- They come in mechanical (redistributing weight) and electrical (enhancing strength) design. Applications include rehabilitation, industrial use, metabolic cost reduction, prevention of musculoskeletal injuries, and load-carrying enhancement.

- Research and development in exoskeletons have evolved since 1890, with various forms developed by different nations.

- Challenges in exoskeleton development include synchronising movement, aligning structural joints of the soldiers, multi-degree of freedom, compact form factor, and optimal interactive force between the system and soldier. Endurance usage and battery life are also significant challenges.

- DRDO aims to identify exoskeleton configurations for specific soldier applications in various terrains. Understanding soldier biomechanics through real-time data collection and biomechanical characterisation during activities is a priority.

- DRDO has developed a human-in-loop integrated performance evaluation system for exoskeletons.

- DEBEL has partnered with academic institutions and industries to advance exoskeleton development.

20. The fourth speaker for the session was **Maj Gen Ajay Kumar Sharma, Dy Comdt MCEME**. His remarks on the use of training and simulation technologies are as follows:

- Displayed the application of Virtual Reality (VR) and Augmented Reality (AR) in military training.

- Discussed the potential of VR and AR in realistic training scenarios and the role of simulation in enhancing training effectiveness.

- Discussed potential challenges and solutions associated with using these technologies in military training.

- Requirement of building operational readiness, unit cohesion, adaptability & flexibility, leadership development, skill development, and physical fitness & resilience.

- Long and extensive, expensive equipment & resources, limited realism in teamed operations and situational awareness, limitations in testing stress, mental resilience and decision making, risks & rigidity in conduct, non-uniformity across training, resource & infrastructure-intensive.

- VR allows immersive experience in a virtual environment, while AR overlays digital content onto the real world.

- Benefits of VR and AR in training include cost-effectiveness and accessibility, higher engagement and retention rate, productive failure and risk mitigation – failures can be multiple and provide lessons every time, realistic simulation, combat scenarios, quick reactions, stress inoculation and mental resilience, improved decision making, remote training and adaptive training scenarios, enhanced teamwork and cohesion with situational awareness and continuous evaluation, feedback and improvements.

- Potential AR and VR training scenarios include immersive scenario-based combat situations, tactical mission planning, rehearsals, decision-support weapon training, equipment operation and MRO training, medical support and combat casualty care training, environmental and terrain familiarisation, navigation, language and cultural training, and flying trainers.

- AR and VR training has been used in the Indian Army to train the soldiers of tomorrow. For instance, MCEME has developed a programme for the T-90 engine. It can train 25 technicians in one go, reducing the cost. The virtual maintained trainer for LCH: Developed in India. There is a difference of 140 crore rupees for training through VR systems. Some of the indigenous VR-based training simulators built in MCEME: VR CMC- Combat Medical Care, AR AMS – Advance Mannequin System, VR OP – Observation Post, VR ADS – Aerial Delivery System, VR IGLA- IGLA 1M Firing, VR RL – 84 mm RL Firing, VIRTAC- Tactical Trainer, VR ACR – Aircraft Recognition, VR TRN – 3D Terrain Visualisation.

Session Outcome

21. The session underscored the challenges and opportunities regarding the effectiveness of technology in preparing the soldier. The session's outcomes are as follows:

- Recognise integrating key technologies such as quantum computing, AI, cyber, communication/networking, space, additive manufacturing, semiconductors, and robotics into military systems to enhance capabilities and preparedness.

- Understand the dynamics of hybrid warfare, including the shift towards small and cheap weapons, the dominance of algorithms, and the significance of digital and space technologies, UAVs, rockets, missiles, and nuclear capabilities.

- Emphasise the need for cyber resilience in the face of ongoing cyber threats, acknowledging the difficulty of attributing cyber-attacks and the importance of being prepared to withstand them.

- Develop strategies for countering drone threats, including deploying tactical drones, portable anti-drone systems at the platoon level, and integrated air defence systems for protecting bases, artillery units, soldiers, and armoured vehicles.

- Recognise the potential of exoskeleton technologies in enhancing soldier capabilities, including rehabilitation, industrial applications, and load-carrying enhancement, while addressing challenges such as movement synchronisation and compact form factor.

- Explore the applications of Virtual Reality (VR) and Augmented Reality (AR) in military training, including immersive scenario-based combat situations, tactical mission planning, equipment operation training, and medical support training.

- Promote developing and utilising indigenous VR-based training simulators, such as those produced by MCEME, for various military training purposes, including combat medical care, observation post-training, and aircraft recognition.

- Advocate for a policy shift to incorporate VR-based training into military training programs and further emphasise collaboration with academia and industry to develop in-house capability and infrastructure for VR-based training.

Concluding Remarks

22. **Lt Gen Tarun Kumar Aich, Deputy Chief of the Army Staff (Strat)**, delivered the concluding remarks of the seminar, reflecting on articulation of the multifarious issues brought to the fore during the seminar. The highlights of his remarks are as follows:

- While the purpose of war remains constant, the methods to achieve goals have evolved significantly driven by the exponential growth of technology.

- Pursuing small and emerging technologies challenges traditional warfare techniques, leading to an unrecognisable future battlefield.

- The private sector is pivotal in developing a state-of-the-art military-industrial complex, serving as a critical partner in technology absorption and innovation.

- The Indian Army has begun to induct emerging technologies in limited amount, aiming to empower soldiers through technological advancements.

- There is a focus on investing in human capital to leverage technology for a decisive combat edge, emphasising the importance of effective communication and decision-making processes.

- Soldiers are equipped with the necessary equipment, and there is potential for human augmentation to enhance soldier strength on the battlefield.

- Collaboration between the private sector and armed forces is essential to foster collaboration and innovation.

Vote of Thanks

23. Vote of Thanks for the seminar was delivered by **Maj Gen RPS Bhadauria VSM (Retd), ADG, Centre for Land Warfare Studies (CLAWS)**. The salient points of his speech, expressing gratitude to all the stakeholders for their contribution and seamless conduct of the seminar, are as follows:

- The Year of Technology Absorption: Empowering the Solider seminar has seen a convergence of minds, strategic thinkers, and experts to deliberate on various pressing issues.

- Each session in the dialogue was infused with a wealth of knowledge derived from speakers of different backgrounds to enhance debates around the various aspects of the Indian Army's absorption of technology and, thus, empower the soldier.

- The knowledge shared, and the insights gained will help guide discussions in the future and help share an understanding of the concepts related to the effective and efficient absorption of technology in the Indian Army.

Conclusion

24. The seminar got concluded on a positive note post the vote of thanks by ADG CLAWS.


Year of Technology Absorption : Empowering the Soldier


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