CENTRE FOR JOINT WARFARE STUDIES

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SIMULATORS FOR THE INDIAN ARMED FORCES

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1. Introduction. Modern military systems are technologically intensive and extremely sophisticated and complex, demanding persistent training to attain proficiency in operation. Simulator based training (SBT) involves replication of operating displays and symbology as well as communication interfaces, control and switch layout and instrumentation. When interfaced with a synthetic realistic environment, it helps combatants orientate and train on handling complex weapon systems and generate more intuitive near real responses to various situations. In recent years, technological advances in electronics and information and communication technologies, coupled with tools for creation of ever more realistic virtual environments has enabled increasing use of SBT for skill enhancement on weapons and equipment, employment in combat situations at tactical/ operational levels, to improve maintenance practices and for operational planning as well as decision making.

2. Advantages. SBT reduces the requirement of mobilising men and material for training and conduct of exercises, with associated savings in terms of cost and resources. The reduced use of expensive equipment and assets brings down the operating and maintenance costs and ensures their longevity. The requirement of expending critical and costly ammunition is also rationalised. Combatants can be exposed to variable combat and

operational scenarios, environments and emergency situations, some of which would be difficult to practice in the field. Training undertaken under close supervision would enhance the training value, honing of skills and responses of trainees, with no risk to life or equipment. It provides tools to evaluate and assess every aspect of training and performance and provide prompt and objective feedback, and instant addressing of errors; something not always possible in a real training environment. Simulators are location and time agnostic, allowing training to be conducted without being constrained by the time of the day, season or weather. Simulation training, when formally integrated with the curriculum, optimises the total training time.

3. SBT has been universally identified to be of three types:

(a) Live Training. Involves real life humans and equipment activity in a physical environment, with only the effects of the activity being simulated. Most contemporary training currently practised is live.

(b) Virtual Training. Involves real participants in a virtual environment, with varying degrees of realism. Different operational terrains and a lot of scenarios can be simulated for individual training or even for limited team exercises. A combination of live and virtual simulations is primarily aimed at perfecting the weapon, equipment and system handling skills.

(c) Constructive Training. Is like synthetic reality where both the humans, as well as the environment, are simulated. Constructive simulation aims at improving and refining the competence of decision makers.

4. The Land-Based Training and Simulation. Encompasses a variety of simulators to cater to specific requirements of each arm or service, as also to the varied terrain and diverse equipment. For example, the Infantry requires robust simulators that cater to the technological threshold of its soldier, while those for the artillery and armoured must provide amalgamation of various skills and trades involved in their operations. The Army Air Defence (AAD) functions in a complex air environment, requiring integration within various organic sensors and weapon systems, as well as airspace management and coordination with the Air Force.

5. Flight simulators. Replicate the cockpit layout and aircraft controls, and artificially create a flight profile and the environment, with varying competencies. They have been utilised for orientation, procedural and

operational training of aircrew. More advanced flight simulators that have been consistently improving in their sophistication include the Full Mission Simulators (FMS) that have value added features for specific roles and missions, including armament training. Full Flight Simulators (FFS) have motion capabilities along the 3 rotational axes of the aircraft, i.e. role, pitch and yaw and dynamic control loading gives the pilot a realistic feel of controls. The fidelity of simulators is defined from level A to D, based on the realism that they can provide. Such simulators have been extensively used in civil aviation for skill and proficiency training as well as evaluation and categorization and have applications for similar military aircraft. However, the currently available FMS lack the capability to replicate the manoeuvrability of the fighter class of aircraft. Instead, flight simulators for fighter aircraft involve fixed bases, augmented with a wide field of view, immersive and high-fidelity visual sceneries. The feel of high g manoeuvres is provided to some extent through other sensory means. The Indian Air Force (IAF) also has basic level Air Combat Simulators to simulate one on one combat to enhance skills of the pilots.

6. Ship Handling Simulators (SHS). Provide realistic simulations of varying fidelity of ships, submarines and harbours for training on various aspects of operations and navigation of ships and emergency situations in all kinds of sea conditions. The more advanced multi-station SHS, located at Indian Navy's (IN) Navigation and Direction School, has four networked trainee stations and can simulate varied ships and submarines and multiple Indian and foreign harbours and Indian beaching sites. With a 360-degree azimuth field of view, it can simulate various visibility and sea conditions to provide realistic training. Further networking could allow training as part of larger fleet manoeuvres.

7. More futuristic developments relate to integrating all three kinds of simulations into Live, Virtual, Constructive, Integrated Architecture (LVCIA). Integrating diverse simulators would allow multiple entities to interact with each other to conduct a multi-player coordinated simulated action in an integrated battle space. More expansive training, so achieved, would greatly enhance skill levels of participating combatants, their mission response and decision-making ability. IAF's proposed Air Combat Tactical and Training Simulator (ACTTS) is being envisioned for simulation of operations involving multiple aircraft and air and ground-based threats. The live component would comprise actual platforms in air, while the virtual component would be aircrew operating diverse simulators at various locations. The constructive component would encompass simulated crew (Artificial Intelligence (AI) enabled) operating simulated systems. Indian Army's (IA) Corps of Artillery

is developing an Artillery Integrated Simulator Training Lab (AISTL) for combined training of all elements involved in firing, to include decision support. Scaling up of this integration would allow simulation across verticals and domains, enabling tri-service training and wargaming.

8. Induction. There are various ways in which simulators are being inducted into the armed forces. A lot of modern software dependent equipment has in-built simulation applications that allow training on all operational aspects related to the training, such as those of BRAHMOS missile and SMERCH rocket system. Simulators have also been procured as part of the contract for new inductions, as in the case of Pilatus and Hawk trainers and more recently for Rafale aircraft. Simulators have been one of the major areas in the defence offset realization in the last few years. C130J simulator being managed by M/S Mahindra Defence Systems and the MiG-29 upgrade simulator by Alpha Design Technology Limited have both been set up under the offset contract. The LCA simulator is a shining example of indigenously designed and operated simulator (ADE), which benefited immensely from the ‘user in the loop’ concept during its development. Private industry, as subsidiaries of global companies or independently have also provided simulators such as the Dornier Flight Training Device (FTD), equivalent to FMS, which has been procured by CAE India. The IAF is also pursuing a Build Operate and Maintain (BOM) concept for some of its sophisticated and multi-use simulators, wherein a private company, whose services are hired on annual or user-based contracts, builds, operates and maintains the simulator.

9. Currently, each service that has cross-domain applications is operating simulators. These include simulators for Air Traffic Control, small arms firing, certain common equipment, sensors and weapon systems, damage response, NBC response, common vehicles driving and so on, for which the technology/resources can be shared. Simulators for UAV systems being developed by Aeronautical Development Establishment (ADE) could be utilised by all three services. Integrated Procurement Of such systems would allow optimal scaling and budget allocation. A recent example of such a process is an EOI taken out by DG Infantry of the IA for 125 infantry weapon training simulators. These include 66 for IA, 32 for the Indian Navy and 27 for the Air Force. Coordinated employment of these systems would help in jointness in training and standardisation of tactics and procedures, which would then enable graduating to joint/ integrated simulated environments.

Wargaming Simulation

10. Wargaming utilises constructive simulation of realistic scenarios and environment at the tactical, operational and strategic level, to provide a human decision-making tool. A combination of a group of equipment, combatants and capabilities can be pitted against similarly aggregated entities to exercise and evaluate operations in various scenarios and ambiguous environments. Besides training, it allows examining and validation of various warfighting techniques and concepts and enables exchange of ideas and information. Wargaming can also be utilised to provide inputs to force structuring, inter-services integration and development of and response to various technological advancements.

11. The IA has a dedicated Wargaming Development Centre (WARDEC) that develops wargames for various resolutions to cater to different decision-making layers, terrain and scenarios. The Navy has its own computer-based wargames, developed in collaboration with DRDO. The Air Force has an indigenously developed a wargaming simulator at the College of Air Warfare (CAW). Wargaming simulators are also used at all the integrated training institutes.

12. Evidently, the scope and complexity of wargaming increases with a move upwards from tactical to strategic level, with action at each level impacting the other. Wargaming applications are being progressed to be multi-resolution – the ability to game across tactical, operational and strategic levels, factoring in all kinds of threats and scenarios. To be truly effective, wargames should avoid mirror imaging of enemy capability or CONOPS. Logical generation and incorporation of time factors, resource limitations, Battle Damage Assessment (BDA) or attrition, ammunition depletion and logistical challenges would enable more accurate game-playing and better decision making. Applications of Artificial Intelligence (AI) should be researched to provide more realistic, intuitive scenarios, rather than scripted ones with predictable outcomes and the ability to incorporate the fog of war and uncertainty.

13. Integrating disparate simulators would require overcoming multiple technological challenges. Distributed interactive simulation standards or protocols should be adopted and emphasised for all new procurements to ensure interoperability. Existing systems need to be made interoperable through indigenous efforts. Multi-resolution wargaming would also be dependent on cloud computing and networking capabilities, supportive and

secure networked environments with adequate capacities, command tools with appropriate user interfaces and responsive GIS.

14. Effective simulator training demands generation and visualisation of the environment and scenarios with realism. Visualisation software and tools developed for commercial applications could be utilised to generate high fidelity, realistic 2D and 3D visuals of terrain and environment and simplistic depiction of operation and executions. Wherever applicable, there is a requirement to graduate from flat screen simulators to dome shaped 360-degree virtual imagery simulators or head mounted display-based simulators that provide a complete 3D picture. The medical aspects related to immersive training need to be studied further for improvements. For wargaming, there is a requirement of virtual replication of a complex operating environment across the whole spectrum of operations into a single synthetic environment. All these would benefit from advances made in the commercial domain, including software and visualisation technologies of gaming applications.

15. Besides training, simulation has emerged as an enabler to development, procurement, scaling and operationalisation of new equipment, evaluate the efficacy of new systems and an effective way to develop, assess and validate new tactics, techniques or procedures. Institute for Systems Studies and Analysis (ISSA), a DRDO organisation, utilises modelling and simulation for designing, development and testing of new products, also assisting other entities with their products. The outputs could be in terms of system specification, cost benefit analysis or the synchronisation with the doctrines and tactics, which could then be used to suggest improvements. For new acquisitions, they could enable selection and performance evaluation at the testing and evolution phases. This optimises and expedites the processes, with corresponding savings. Simulation could also be used to test various logistical processes for their efficacy, to improve the combat capability of the forces.

16. Most of the current crop of simulators in the armed forces is PC based, operate at the individual level and lack realism and sophistication. This has caused inadequate and casual utilisation, resulting in sub-optimal training efficacy and impeding investments in capability enhancement. Recent years have seen growing acceptance of simulation-enabled training, but transforming mindsets and perceptions through awareness remains an ongoing process.

17. It is equally important to appreciate that SBT cannot totally obviate the necessity for real training in live environments. Each induction, development or procurement should be benchmarked against the optimization factor – the balance between live training and simulator training for each combatant element as also for joint/integrated training. Mathematical models exist that could be suitably applied.

18. For SBT to be really cost effective, the systems must be scalable, replicable and upgradeable. This would also allow smoother conversion onto more modern equipment and systems and to evolution in operations. Scaling up should be based on extensive cost-benefit evaluation and be benchmarked against the procurement and lifetime costs and resource allocation. Open architecture systems, adhering to industry standards, should be preferred among all new inductions to enable customisation and upgrading. Modern simulators are large, complex machines that require corresponding investments in specialised facilities and infrastructure, which need to be factored in the acquisition process. Optimisation in the number of simulators through planned utilisation and establishment of simulator training nodes would rationalise the employment of skilled manpower, standardise training and address maintenance issues. Simulators with flexible hardware and software that could cater to varied layouts and diversity of equipment would also help rationalise numbers.

19. Policy. The armed forces have made significant progress in the field of simulator training but there still exists a need to identify their future requirements and devise a roadmap for procurement, employment and maintenance of simulators towards joint training and operations. Having identified this, in September 2021, the Ministry of Defence (MoD) promulgated the latest policy framework on implementation of SBT across all military domains, with an aim to reduce the live equipment utilisation by approximately 20 percent over the next five years.[1] The vision of this document is to ‘standardise and enhance exploitation of simulators by the three services and Coast Guard to achieve cost effective, efficient, safe, fast paced and smart training.’ The framework lays emphasis on indigenous design and development as well as outsourcing of operation and maintenance of the simulators to Indian companies. A simulator procurement plan, both short term and mid-term, is already included in the directive and the service headquarters have been directed to formulate comprehensive roadmaps, promulgate the envisaged procurement plan through the Technology Perspective and Capability Roadmap (TPCR) and issue suitable guidelines for the industry. The definitive policy has already

stimulated more dedicated efforts towards induction and adoption of SBT and wargaming within the services and through joint initiatives.

20. Augmenting the sophistication and capabilities of simulators will be achieved by boosting system memories, achieving faster computational speeds and enhancing processing power. Disruptive technologies, such as AI, Machine Learning (ML) and Big Data Handling have the potential to revolutionise the capabilities in terms of performance, providing decision making tools and practicing and testing in uncertain and unpredictable scenarios or environments. Virtual Reality (VR), Augmented Reality (AR) and extended reality applications have the potential to enhance the visualisation, realism and immersive experience. There is a need for a national level conceptual framework for futuristic technologies to enable a more coordinated approach to R&D, including those related to simulation.

21. Challenges related to simulators over their lifecycle include maintenance of hardware and obsolescence issues, at times influenced by the OEM's commercial interests. Simulators are data driven and data access, compilation and processing, information security of sensitive data, and licensing of software have been contentious issues. These have adversely impacted regular updating of systems to cater to evolution of features and functionality of the equipment. The Annual Maintenance Contract (AMC) is the most widely used model, as inhouse servicing does not always produce the best results, while blocking vital resources. The IAF has started embedding AMC in the procurement process and using it to determine the L1 window, to allow competitive and comprehensive pricing. Steps must however be taken to avoid a potential vendor lock situation with its associated exploitative consequences.

22. Industry Efforts. The surge in conflicts worldwide, enhancement of system capabilities and an emphasis on cost savings have contributed to the growth of the military simulation and virtual training marketglobally. While the airborne simulation segment currently holds the largest market share, SBT in other domains are also growing exponentially. With the policy and budgeting becoming supportive, more simulators are expected to be operationalised in the future. Although the global defence simulation and training industry is dominated by a few established large companies operating through locally established subsidiaries, the proliferation of technology in recent times provides opportunity for more indigenous efforts and participation by many private players to garner a share in this market through R&D and software and hardware development. They could participate in the development of new simulators, upgrading legacy ones

and also in cost-effective maintenance contracts for existing and the new systems that are inducted. Obsolescence management plans and updating of software and data bases could also be entrusted to these companies and those operating on the BOM model.

23. Industry vs Inhouse Predicament. The industry, through its more focussed R&D and innovation, is more suited to meet the technical challenges of highly sophisticated systems and more complex training. Outsourcing also helps save manhours and costs for the services. Inhouse development, on the other hand allows tailoring to meet specific user requirements, is cost effective for the entire life cycle, as also for upgrading. Requirements of outsourcing, inhouse development and collaborative efforts need to be identified. Various methodologies of engagement with industry could be explored, with viable business models including the long-term technical support, defined logistical footprint and emphasis on indigenous content.

24. Conclusion. The growing complexity of conflict and sophistication of equipment, coupled with the budgetary constraints demand an increasing emphasis on simulation-based training, testing and gaming to prepare future combatants and leaders. Scaling up of simulated mission and combat capability would require persistent efforts at upgrading of technological and visualisation capabilities, integration of more consoles and nodes and amalgamation and handling of diverse data. The promulgation of an integrated policy framework by the MoD has provided the desired impetus for adoption and enhancement of SBT and wargaming by the services. It is important that the current desegregated and distributed approach give way to a more synergised one to enable more responsive joint training. All commanders must be educated on the common guidelines and policy through various in-service means to ensure that the implementation and execution match the intent. Advancement in technology and evolution of operational missions and tasks would demand regular update and recalibration of the relevant policies, procedures and guidelines related to acquisition, employment and maintenance of simulators.

CERTIFICATE

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[1] "FRAMEWORK FOR SIMULATORS IN ARMED FORCES" by Ministry of Defence, Government of India, accessed at https://www.mod.gov.in/sites/default/files/FRAMEWORK%20FOR%20SIMULATORS%20IN%20ARMED%20FORCES%20SEP%2021%20-%20Copy.pdf, 15 Mar 2022