Simulation Technology and Analysis of Military Simulation Training

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Abstract. In view of the vigorous development of simulation training technology, the classification, research status and development direction of simulation training technology at home and abroad are studied, which provides reference basis for equipment simulator research. Modern simulation trainer is a multi-component platform by means of simulation technology, which has the characteristics of more pertinence and more comprehensive training elements than traditional training mode.

Keywords: Simulation training, simulation technology, fidelity.

1. Introduction
Simulation training is a process that comprehensively uses modern simulation technology based on computer technology, virtual reality technology, distributed simulation technology and artificial intelligence technology to simulate weapon system performance, combat environment, combat opponent, combat mission and combat process with high fidelity, which can make the department (sub-team) and trainees feel the atmosphere close to actual installation and close to actual combat, and maximize their training level. By constructing a realistic simulated training environment and relying on modern science and technology, simulation training is less affected by economy, weather and personnel, which can objectively and effectively reflect the training level of the training unit and has stronger training pertinence. In view of this, both at home and abroad attach great importance to the development and application of simulation training technology.

This paper studies the classification and characteristics of simulation training, analyzes the characteristics of American simulation training, and compares and explains the gaps in simulation training in China, which provides a direction for military simulation training.

2. Classification and Characteristics of Simulation Training
2.1. Classification of Simulation Training
According to different application levels, military simulation training can be divided into equipment skill simulation training, campaign tactics simulation training and strategy simulation training. Equipment skill simulation training refers to simulation training to improve the level of equipment operation and management support, which can be divided into operation simulation training and maintenance simulation training. Campaign tactical simulation training launches combat command and coordinated action drills around specific combat tasks. Strategic simulation training mainly studies strategic level issues, assists middle and senior commanders in making strategic decisions, and also helps to form strategic thinking.

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Operation simulation training refers to simulating the operation process of weapons and equipment by means of simulation technology, which saves time and effort, can reduce the technical wear of weapons and equipment, and is widely used in various types of military equipment training. Maintenance simulation training refers to simulating the whole process of maintenance by means of simulation technology, including three stages: fault presentation, fault analysis and fault elimination. Virtual maintenance can solve the problems such as difficulty in fault reappearance and unsuitable for practical training.

2.2. Characteristics of Simulation Training
Compared with actual training, simulation training has the advantages of advanced technology, comprehensive elements, intuitive process and objective results.

2.2.1. Advanced technology. Simulation training is a kind of training means which integrates multi-disciplinary knowledge, and it is the innovation and development of traditional training mode. Its advanced nature and technicality have been confirmed in the process of practical application. With the continuous development of VR (DR) technology and distributed interactive simulation technology, the level of simulation training technology has been improved, and its advantages have been continuously highlighted.

2.2.2. Comprehensive elements. The simulation platform can simulate various operational elements, including: enemy/enemy situation, joint forces, electromagnetic environment, geographical environment, weather and hydrology, etc. These elements can be static or dynamic.

2.2.3. The process is intuitive. Large-scale distributed interactive platform is widely used in simulation training. The guidance and control terminal of simulator can obtain the information of trainees and equipment in real time, and can restore the images, sounds and data streams of training environment by means of video monitoring and data monitoring, thus providing trainees with more intuitive and real feelings.

2.2.4. The result is objective. Simulation training comprehensively utilizes the method of combining qualitative analysis with quantitative analysis, and carries out simulation experiment by establishing mathematical model, semi-physical model or physical model. The system is more scientific and logical than manual system, which can minimize the influence of subjective factors and make the training result more objective.

3. Research Status of Simulation Training Abroad
The U.S. military is the pioneer and beneficiary of simulation training, which is widely used and has achieved the most remarkable results. The U.S. military simulation trainer not only has the advantages in quantity, but also can fully realize the "three mutualities", that is, interconnection and interoperability. Take the U.S. Army as an example. The U.S. Army has built a large number of simulators with different types and different levels from platoon level, brigade battalion level, military division level to theater level. Moreover, the Army can not only realize internal information exchange, but also complete networking with other simulation trainers such as air force, navy and support, and form a "United States Army Joint Training Federation", sharing information situation in time, and greatly improving combat capability. There are three types of simulation training in the US military: virtual reality application training, advanced distributed interactive application training, and virtual reality combination application training.

3.1. Virtual Reality Training
Based on virtual reality technology (VR) or augmented reality technology (AR), with the help of various output devices, input devices or other action interaction devices, a virtual and extremely realistic combat environment can be constructed. In the environment, through the support of hardware devices, "deceive" people's feelings and achieve the purpose of "reality". Generally, the output devices
are mainly head-mounted displays (including headphone interfaces) and VR glasses to realize visual and auditory output; Input devices and action interaction devices include simulated individual weapon with sensors and various motion trackers, which can realize good interaction between human and system. At present, the U.S. military has widely applied virtual reality technology to individual basic training, cooperative command support training and campaign tactical exercises. In Iraq War, in order to solve the problem of field escort, the U.S. military urgently developed the simulation training system of field escort. The system truly reproduces the whole picture of Baghdad, and can conduct real drills aiming at the tasks to be performed, escort routes, and unexpected attacks that may be encountered. At the same time, the system is supported by the Joint Conflict and Tactical Simulation (JCATS) system, which can expand multi-vehicle cooperative operation and temper collective combat capability.

3.2. Advanced Distributed Interactive Training

Through distributed network, hardware, software and personnel scattered around are connected to form a virtual combat environment which is highly coupled in time and space and shared in real time. From the military point of view, distributed interactive technology can couple weapons and equipment, simulation equipment and trainees from all over the world to form the same simulation training system, which realizes multi-platform collaborative training in the same system, effectively solves the problem of difficult scheduling of actual military exercises and relieves the pressure of post-installation support.

3.3. Training with Combination of Reality and Reality

While vigorously promoting simulation training, the US military also pays great attention to the practical test function of actual training. Combining simulation training with actual training can integrate their strengths, avoid their weaknesses and really play the role of simulation training multiplier. The European Command of the U.S. Army has explored and implemented live-fire shooting exercises combining actual combat, virtual combat and weapon deduction. The exercise environment combining actual combat with actual combat can organize the integrated training from individual soldiers to battalion commanders, provide a higher level and wider range of action environment, strengthen the understanding and execution of tasks by commanders, and enhance the consistency between simulation training and actual combat training. The application of simulation training will have an impact on live-fire shooting and actual training, but the purpose of simulation training is not to replace actual training, but to enhance the actual training level and improve the operational skills of commanders and trainees. Spreading out the training mode of combining virtual with real is beneficial to fully allocate training resources, and the synchronous and integrated training environment is beneficial to the integration of individual soldiers, commanders or higher-level and more categories. As shown in the following figure.

Figure 1. Schematic diagram of the US Army's integrated actual, virtual and deduction.

4. Domestic Simulation Training Research and Analysis

China's simulation training technology started late, and its development momentum came from behind. At present, all arms and services have built their own simulation training systems, and their supporting technology is not a single simulation technology, but a fusion of various technologies. ZHANG Kai
put forward a shooting simulation system for unmanned boats, which was modified on the basis of actual installation. Virtual reality technology (VR) was used to enhance the immersion of trainees and enhance the training experience. The "Strong Army" simulation training system jointly developed by Nanjing Strong Army Network Technology Company and National University of Defense Technology is the first cross-platform multi-person virtual reality simulation confrontation training system in the whole army. Based on virtual reality technology, the system uses PC terminal, VR terminal of Type 95 rifle and VR glasses to make the participants immersive, and can organize individual shooting training and team confrontation training in two different scenes of street fighting and field fighting. In view of the limitations of long-range rocket launcher installation training, such as large land occupation, more equipment and strict environmental requirements, Li Siyu put forward a design idea of simulation training system, and built a simulation training platform installed in the loop through distributed interactive network. With the help of hardware-in-the-loop simulation technology and virtual reality technology, the system can not only train the tactical content of the whole process of distant fire, but also organize the training of operation subjects and maintenance subjects specified in the military training syllabus, thus effectively improving the equipment operation ability and common troubleshooting ability of operators. At the same time, the system also has the function of training evaluation, which can record the operation process in detail and feedback the training suggestions, providing ideas and reference for the research of simulation trainer of complex weapon system.

Although the simulation training system plays an obvious role, it also has disadvantages. This is because simulation training is not equal to actual combat training, and winning the simulated battlefield does not mean winning the actual war. High dependence on simulation training, long simulation training time and short installation training time lead to weakening of installation operation ability; In addition, there will be no fatigue, bleeding and pain in training in virtual environment, but the actual battlefield situation is far more complex and cruel than that in virtual environment. It is unwise to use simulation training to completely replace actual combat training, and it is easy for trainees to underestimate the difficulty of war and cause the illusion of victory. Therefore, actual combat training is also essential, and simulation training and actual combat training complement each other. In order to reduce the difference between them and improve the benefit of simulation training, we should focus on developing simulation training from the following aspects:

4.1. Unified Management System of Simulation Training

The unified management system is the important reason why the simulation training level of the US military leads the world. As early as 1991, the US Department of Defense set up the Modeling and Simulation Office, which was responsible for docking, summarizing and coordinating the demands and suggestions of various services, and each service had its own combat laboratory. In contrast, we just lack this guarantee. The current simulation training management is a part of military training management, and it is managed by non-full-time personnel. Managers do not have excellent knowledge literacy of simulation training. Most simulators distributed to grass-roots units have been shelved, and the effectiveness of training has not been brought into play, which is also related to the management system.

4.2. The Simulation Trainer is Multifunctional

The simulator should be changed from single energy to multi-energy to realize multi-field development. In terms of functional elements, the simulator should have the ability of individual training and cooperative training, equipment operation training and command and decision training at the same time; On the training object, the simulation trainer can train the direct combatants, staff officers and commanders separately or simultaneously; In terms of module composition, the simulator
not only has a training management module, but also has modules such as guidance and adjustment monitoring, performance evaluation and comprehensive support.

4.3. Expand the Group Training Mode of "Simulation Training+Actual Training"
The purpose of simulation training is to improve the training level and combat capability of trainees by means of realistic training environment. Through virtual reality technology, advanced distributed interactive technology, etc., a virtual combat environment with highly shared vision, hearing and touch is built, so that trainees can start training in an approximate actual combat environment, which can ensure the consistency between simulated training and actual combat. At the same time, regular joint military exercises and exercises of simulated training results can realize the effective transformation from training level to combat capability.

5. Concluding Remarks
Simulation training technology reflects the current technical level of society. With the rapid development of modern science and technology, the fidelity, integration and connectivity of simulation training system are getting better and better, and the role of service and guidance training level is becoming more and more prominent. Focusing on improving the fidelity of simulation training, this paper studies the classification, research status and development direction of simulation training technology at home and abroad, which provides technical basis for the research and development of various weapons and equipment simulators. In the next step, using virtual reality technology to enhance the fidelity of simulation training is bound to be the focus of research.

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