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CHAPTER 4

MODERN APPROACHES TO PROJECT MANAGEMENT IN THE TRAINING OF NAVAL OFFICERS. USE OF SIMULATION TECHNOLOGIES

ABSTRACT

This chapter of the monograph is dedicated to project management in the military sector, using the example of a virtual project for the training of military officer-navigators. In the context of modern military conflicts, where the demands on the training of military specialists have increased significantly, the introduction of advanced technologies is a key factor for ensuring effective training. This project utilizes VSTEP (NAUTIS) and KILO-VASCO simulation platforms, providing realistic training for officers in a virtual environment. These platforms allow for exercises in scenarios that closely replicate real combat conditions. The chapter examines key aspects of project management, such as planning, resource management, risk management, and the integration of virtual technologies into the training process. Additionally, the effectiveness of the project is evaluated, and its development prospects are outlined. This experience represents a valuable example of an innovative approach to military training in Ukraine, which may also be beneficial to other countries facing similar challenges.

KEYWORDS

Education, project development, project management, simulation, virtual reality.

In the conditions of modern challenges, in particular during armed conflicts, there is a growing need to train military personnel at a high level of professionalism, especially in the field of complex project management. Project management in the military sphere requires special attention to resources, deadlines and quality of execution, because not only the success of training depends on this, but also the safety of personnel and the effectiveness of combat missions.

Today, military projects cannot be imagined without the introduction of the latest technologies that ensure a high level of interactivity and realistic training. This is particularly important for the training of officers responsible for ship management and operations at sea. The implementation of virtual simulations allows to reproduce real combat conditions, where the cadet can train repeatedly without risking health and equipment.

The purpose of this project is to integrate modern simulation technologies into the process of training for naval navigation officers, which will allow them to be maximally prepared for difficult and dangerous situations that they may encounter during real combat operations. The success of such projects depends on effective management, which includes planning, resource management, risk management, and implementation control.

The relevance of the implementation of simulation systems is well illustrated by the incident that occurred in 2018 with the Norwegian frigate "Helge Ingstad". After completing NATO military exercises, the ship collided with an oil tanker due to errors in navigation and insufficient preparation of the crew for working in conditions of limited visibility. This collision resulted in serious damage to the frigate and its sinking. The lack of an opportunity to repeatedly practice critical scenarios, such as difficult navigation in conditions of limited visibility, became one of the reasons for this tragedy [1].

The incident highlighted the importance of introducing modern simulation technologies into the process of training officers, as they allow repeated training in conditions as close as possible to real ones, but without risk to life and equipment. As an instructors, we are convinced that the use of simulations not only increases the effectiveness of training, but also builds the confidence and professionalism of future commanders, which is extremely important in the conditions of modern military operations.

In this introduction, let's emphasize the importance of simulation technologies, in particular the VSTEP (NAUTIS) and KILO-VASCO platforms, which provide realistic learning. The need for an innovative approach to project management in the conditions of modern military conflicts is also emphasized. As instructor who have experience working with young people and a desire to pass on knowledge to a new generation, we are convinced that such technologies not only increase the effectiveness of training, but also form the confidence of cadets in their readiness for real challenges.

4.1 OVERVIEW OF MODERN TECHNOLOGIES FOR TRAINING MILITARY OFFICERS

4.1.1 THE ROLE OF SIMULATORS IN MILITARY EDUCATION: HISTORY AND CURRENT TRENDS

Military education for many centuries was based on the principles of real experience and field training. However, with the development of technology, the question arose about safer and more effective training methods that allow practicing complex combat scenarios without risk to people and equipment. It was then that simulators became an important element of military training.

The first attempts to use simulation technologies in the military field date back to the beginning of the 20th century, when mechanical and electromechanical simulators appeared for training pilots and gunners. Simple mechanical simulators helped the military master the basic principles of navigation and weapon control. For example, during the First World War, flight simulators allowed pilots to simulate flight conditions and various types of combat missions, reducing the need for real flights, which were expensive and dangerous.

During the Second World War, there was a significant expansion of the use of simulators. One of the most famous examples was the "Link Trainer" simulator, which was widely used to train pilots in the United States and Great Britain (**Fig. 4.1**). This simulator allowed pilots to train in low visibility conditions and simulate different situations without having to take to the air, which reduced the number of accidents and losses during training [2].

Fig. 4.1 "Link Trainer" simulator

With the development of computer technologies in the second half of the 20th century, military simulators underwent a significant evolution. Computer systems have made it possible to create much more complex and realistic simulations imitating real combat conditions, including tactical operations, firing from various types of weapons, piloting aircraft, tanks and ships.

An important stage was the introduction of interactive simulators, which allow not only to observe, but also to actively participate in the simulation of combat operations. Simulators such as the early computerized simulators for fighter pilots and tank crews allowed military specialists to train in conditions close to the real thing, but without the risk to men and equipment.

Today, simulation technologies are experiencing a new round of development thanks to the introduction of virtual reality (VR) and augmented reality (AR). These technologies allow to create fully interactive environments that provide high realism and immersion in combat conditions.

One of the key trends is the use of virtual learning environments. VR-based simulators, such as the VSTEP (NAUTIS) and KILO-VASCO systems, provide realistic simulation of combat operations and training in conditions as close as possible to real life. Military specialists can train on virtual training grounds simulating the conditions of real combat, learn to control a ship or practice complex navigational maneuvers. These systems allow cadets and officers to practice scenarios without risk to life and equipment, which significantly increases the effectiveness of training.

Another trend is the use of network simulations, which allow to train entire units in interaction with each other, even if they are physically located in different places. Network simulations provide the ability to simulate complex cross-species operations where interaction between Army, Navy, and Air Force units is critical to mission success.

Thanks to the development of artificial intelligence (AI), simulation systems acquire the ability to automatically adapt the complexity of scenarios according to the level of training of cadets. AI-systems used in simulations can simulate the behavior of opponents or other elements, which allows cadets to practice scenarios that correspond as closely as possible to real combat conditions.

Modern simulation technologies allow not only to simulate combat conditions, but also to evaluate the effectiveness of training in real time. For example, instructors can immediately receive detailed data about the actions of cadets in virtual scenarios, analyze their mistakes and provide recommendations for improving skills.

In addition, simulators can significantly reduce training costs. The use of virtual simulators reduces the need to use expensive equipment and weapons during training, which is an important factor for military budgets, especially in difficult economic conditions and during a high probability of enemy missile strikes with the subsequent destruction of training simulators and platforms.

Thus, simulation technologies have become an integral part of modern military education. They allow to train military officers in safe but realistic conditions, practice multiple scenarios and significantly increase the level of training, which is critically important in today's environment.

4.1.2 OVERVIEW OF VSTEP (NAUTIS) AND KILO-VASCO TECHNOLOGIES: FEATURES AND CAPABILITIES

Modern simulation technologies provide naval navigation officers with the opportunity to repeatedly train in conditions as close as possible to real ones, but without risk to life and equipment. One of the most powerful platforms for such training is the VSTEP (NAUTIS) and KILO-VASCO systems. These technologies have a wide range of functionality and features that allow them to be used for the training of both novices and experienced military specialists.

VSTEP is one of the leading developers of simulation systems for the maritime industry and the military. Their NAUTIS platform specializes in creating realistic simulations for naval officers and ship operators. The main feature of this system is its high realism and modular structure, which allows to configure the simulator according to the requirements of a specific training scenario.

Main capabilities of NAUTIS (**Fig. 4.2**):

1. Realistic simulation: the system provides an accurate reproduction of real marine conditions, including weather conditions, ship behavior and environmental effects on navigation.

2. Modularity: NAUTIS offers various modules for working out specific scenarios – from basic navigation training to complex operations in crisis situations. This allows instructors to choose those scenarios that meet the learning objectives and level of training of the cadets.

3. Interactivity: cadets have the opportunity to fully immerse themselves in the educational process thanks to the possibility of interaction with other training participants. Network mode allows to practice joint operations between several ships or crews.

4. Ability to simulate emergency situations: NAUTIS allows cadets to practice actions during emergency situations at sea, such as collisions, fires or loss of control of a ship or receiving battle damage. This provides the possibility of repeated training without risk to life and equipment.

5. Visualization and reporting: instructors can receive detailed statistics for each training session, including analysis of trainee errors and recommendations for improving skills.

Fig. 4.2 NAUTIS simulator (VSTEP Naval training)

The NAUTIS system is actively used in training centers and academies of the naval forces for the training of officers and personnel. Its capabilities allow to practice both basic navigational tasks and complex operations for managing large navy ships in various conditions [3, 4].

KILO-VASCO technology is another leading solution in the field of virtual simulations for the training of ship operators. This platform offers a wide range of functions for practicing complex maneuvers, managing the ship in crisis situations and coordinating team operations. The peculiarity of KILO-VASCO is that it integrates modern technologies of virtual reality (VR) and augmented reality (AR), which allows cadets to be even more deeply immersed in training scenarios.

Main features of KILO-VASCO (**Fig. 4.3**):

1. Virtual reality (VR): the system supports full-fledged VR scenarios that allow cadets to be in a virtual environment that is as close as possible to real combat conditions. This increases the level of immersion and allows to train in conditions where sudden changes in situations or danger are possible.

2. Augmented Reality (AR): KILO-VASCO integrates elements of augmented reality, which allows virtual objects to be superimposed on the real environment for additional analysis and training. For example, cadets can see additional information about the environment or receive instructions directly during tasks.

3. Customization flexibility: the system allows easy modification of training scenario parameters in real-time, enabling instructors to modify tasks according to the situation. This is useful for working out unusual situations or adapting tasks for cadets of different training levels.

4. Training in multitasking conditions: KILO-VASCO allows to simulate complex operations where the crew has to perform several tasks at the same time. This is important for training cadets to coordinate actions in stressful conditions or during complex operations.

5. Support for training centers: the platform is used in military educational institutions to organize team exercises, where several crews or units can train together to solve joint tasks. Network mode allows to organize joint training regardless of the participants' geographical location.

Fig. 4.3 KILO-VASCO virtual environment (KILO Solutions)

Common advantages and prospects for development. Both VSTEP (NAUTIS) and KILO-VASCO offer exceptional training opportunities for naval officers in modern environments. Both systems are highly flexible and can be used for training in both basic and more complex scenarios. It is important to note that the use of these technologies significantly reduces the costs of real training, and also allows multiple repetition of training scenarios to achieve maximum results.

Both platforms have prospects for development due to the further integration of artificial intelligence and the expansion of opportunities for real-time interaction between teams working on joint tasks. This makes them key tools for training a new generation of military specialists capable of operating effectively in difficult combat conditions.

4.1.3 COMPARISON OF SIMULATION TECHNOLOGIES IN DIFFERENT COUNTRIES AND THEIR USE IN THE MILITARY SPHERE

Modern simulation technologies play an important role in the training of military personnel in various countries of the world. They make it possible to create safe and realistic training environments where the military can train in conditions as close as possible to real combat operations.

However, approaches to the development and implementation of such systems differ depending on the country, technical capabilities and military requirements.

The United States of America is a world leader in the development and use of simulation technologies for military training. One of the best-known examples is the Joint Simulation Environment (JSE), which is used to train pilots and crews of various types of aircraft. This system allows to create integrated training environments for different military branches – Air Force, Navy and Ground Forces. JSE is distinguished by the possibility of simultaneous simulation of operations with the participation of several types of troops, which allows the military to practice interaction in complex combat conditions [7].

In the USA, the Live, Virtual, Constructive (LVC) system is also actively used, which combines real and virtual training components, providing the opportunity to learn both in real conditions and in simulated virtual scenarios. This reduces the costs of real-world training and minimizes risks, while providing soldiers with realistic training conditions [8].

Great Britain has placed great emphasis on the development of simulation technologies to reduce the costs of real training and improve the quality of training of military specialists. One of the most striking examples is the Virtual Battlespace 3 (VBS3) platform, which is used for ground forces training. This system allows to simulate a wide range of combat scenarios, from simple patrols to complex operations involving artillery, aviation and armored vehicles. VBS3 is also actively used by NATO to practice joint military operations [9].

The British military has also implemented the Synthetic Wrap system, which uses virtual technology to train Royal Air Force pilots. It allows to conduct training in conditions close to real combat operations, without the need to fly on real aircraft, which significantly reduces training costs [11].

Germany is also one of the leading developers of simulation technology for military training. Special attention should be paid to the use of Garrison Combat Trainers (GCT), which allow the military to practice combat skills in complex urban environments. These simulators integrate real combat components with virtual ones, which allows to create the most realistic training scenarios.

In addition, Germany actively uses simulations to train military drivers and tankers. Tank simulators like the Leopard 2 Simulator allow crews to practice combat and maneuver tactics in a variety of environments. This reduces the wear and tear of the equipment and allows to improve the qualifications of the crews without risking the equipment [11].

Ukraine is also actively developing simulation technologies for military training, especially given the complex security situation in the region. One of the most important steps in this direction is the implementation of VSTEP (NAUTIS) and KILO-VASCO simulators for the training of navigation officers. These platforms allow to create realistic scenarios of maritime operations, which significantly increases the level of training of officers without the need to go to the open sea.

The Ukrainian army also actively uses simulations to train drone operators and gunners, which allows effective training of personnel even in difficult combat conditions. Given the ongoing military conflict, simulation technology has become a key element in the training of new military personnel.

Different countries approach the development of simulation technologies depending on their military needs and technical capabilities. However, the general trend is to increase the use of virtual training environments that provide realistic combat scenarios without risk to life and equipment. The use of artificial intelligence and integration with real components makes simulations even more effective. A comparison of the simulation systems of different countries shows that they all strive to reproduce combat conditions as realistically as possible, preparing the military for various scenarios of warfare.

4.2 PROJECT MANAGEMENT IN THE CONTEXT OF MILITARY TRAINING

4.2.1 BASICS OF PROJECT MANAGEMENT: PRINCIPLES AND STAGES

Project management is a complex process that involves planning, organizing, controlling, and executing specific tasks to achieve defined goals within a defined time frame and with limited resources. In the military field, project management has its own characteristics, since it is about projects that affect the security, efficiency of military operations and training of personnel. However, the basic principles and stages of management remain constant and are used in many areas.

Basic principles of project management:

1. Clear definition of goals. Every project should have clearly defined, measurable goals. For military projects, it can be, for example, the training of a certain number of cadets or the achievement of a certain level of qualification of officers. The objectives must be aligned with the project requirements and the general strategy of training military personnel.

2. Project management triangle: scope, time, resources. Any project, regardless of its field, has three main components: scope of work, time frame and resources. Changing one of these elements inevitably affects the others. In military projects, this is particularly important, as resources (human, financial or technical) are often limited and time frames are tight due to the need for operational preparation for actual combat operations.

3. Planning. The basis of the success of any project is its careful planning. This involves the creation of a detailed plan that includes all stages of project implementation, task allocation, performance control and monitoring. In military training, this may include the development of training plans, schedules of training modules, and coordination between various training units.

4. Risk management. Military projects are associated with a high level of risks – from technical failures to external threats. Risk management consists in identifying potential problems, assessing the probability of their occurrence and developing action plans to minimize the consequences. This is important to ensure the smooth operation of simulation systems or the execution of training programs in military academies.

5. Flexibility and adaptability. In the context of military training, the ability to adapt a project to changing circumstances is important. For example, new military challenges or technological

opportunities may arise that require changes to existing plans. Flexible project management (Agile) allows to quickly adapt to these changes.

The main stages of project management (**Fig. 4.4**):

1. Project initiation. At the initial stage, the general vision of the project is formed. This stage includes defining the main goals, scope of work and required resources. Military projects are often initiated by leadership or the need to improve certain aspects of personnel training. For example, it can be the development of a new training program based on simulation technologies.

2. Project planning. Planning is the basis for successful project implementation. At this stage, specific tasks are defined, roles and resources are allocated, and key performance indicators are established. For military projects, planning also includes coordination with government agencies and international partners in the case of projects related to NATO or joint exercises.

3. Implementation of the project. The implementation of the project involves the implementation of all planned works and the achievement of the set goals. At this stage, team management, constant monitoring of progress and solving current problems are critical. In military projects, for example, this can be the introduction of new training assets and technologies, such as simulators, into the training process.

4. Control and monitoring. The control stage involves constant monitoring of results and correction of deviations from the plan. Various tools are used for this, such as regular reports, monitoring of budget and deadlines. In the context of military training, this may include monitoring the effectiveness of simulator training and correcting training programs.

5. Completion of the project. Project completion includes the formal completion of all tasks, evaluation of the results achieved, and documentation of lessons learned for subsequent projects. In military projects, this can be, for example, the completion of a training course using simulators and an analysis of the effectiveness of training cadets. The final report may also include recommendations for improving future training programs.

6. Assessment and study of results. After the completion of the project, it is important to evaluate its success and study the experience gained. This allows to identify weak points and develop recommendations for improving the management of future projects. In the military, this may include assessing the level of training of military officers after training in simulators.

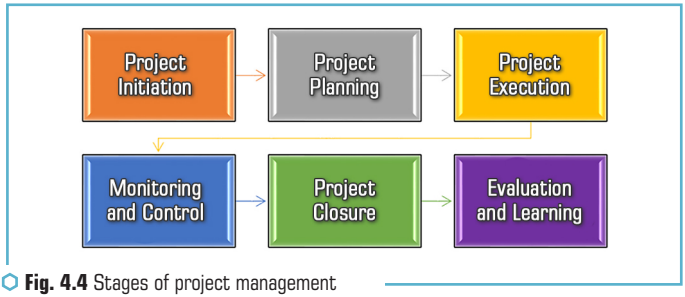

Fig. 4.4 Stages of project management

4.2.2 PECULIARITIES OF MILITARY PROJECT MANAGEMENT: REGULATORY AND LEGAL ASPECTS AND SPECIFIC REQUIREMENTS

The management of military projects has its own characteristics, due to the need to comply with regulatory requirements and standards that regulate this activity at the national and international levels. Special attention is paid to coordination between military units, government bodies and international partners, especially in the context of military coalitions and operations according to NATO standards.

Military projects, in particular those related to the training of personnel, the introduction of new technologies or military operations, are subject to regulation by both national and international acts. In order to effectively manage such projects, it is necessary to adhere to certain requirements and standards aimed at ensuring safety, efficiency and legal compliance.

National normative documents. In many countries, military projects are governed by specific laws, government regulations and Ministry of Defense instructions. This includes the regulation of financial costs, the use of human and material resources, as well as the compliance of measures with the national defense strategy.

For example, in Ukraine, the management of military projects is regulated by the Law of Ukraine "On Defense", the National Security and Defense Strategy, as well as the instructions of the Ministry of Defense regarding the introduction of new military technologies and projects [12].

Norms of international law. Military operations and projects are often implemented under international obligations, especially when a country is a member of coalitions or defense alliances such as NATO. This means the need to comply with the norms of international law, in particular the Geneva Conventions and other documents that determine the rules for conducting military operations and protecting the civilian population.

NATO's requirements for the management of military projects. There are certain standards and requirements for the management of military projects for NATO member countries, as well as for partner countries that cooperate with the alliance. The main regulatory and legal documents that regulate military projects and operations within NATO are NATO guidelines (STANAG), extreme tactical instructions (EXTAC), as well as training and interoperability standards between the military units of member countries:

1. STANAG (Standardization Agreement). STANAGs are NATO's primary documents that govern standardization between member nations' armed forces. Military projects, especially those related to the introduction of new technologies or joint exercises, must meet the requirements of STANAG. For example, STANAG 6001 deals with language training for military personnel to ensure mutual intelligibility during joint operations, and STANAG 4586 with standards for unmanned aerial vehicles used in military operations [13].

2. EXTAC (Extreme Tactical Instructions). EXTAC is a set of instructions that govern the tactical aspects of military operations in difficult or extreme environments. These may be requirements for operations in difficult terrain, poor visibility or combat operations at sea.

EXTACs provide the military with detailed instructions for managing tactical elements during combat operations. For example, EXTAC 1000 determines the coherence of the actions of naval units on the water during joint maritime maneuvering and the implementation of various tactical procedures [14].

3. NATO's "Smart Defense" concept. As part of the Smart Defense concept, NATO aims to optimize the use of resources in military projects through cooperation between member countries and the exchange of technologies. This is aimed at avoiding duplication of military development and improving project coordination. In the context of project management, this means the need for close cooperation between governments, military and industrial partners to ensure the mutual benefit of military innovation [15].

Specific requirements for the management of military projects. Military projects require special attention to security issues. Information related to projects is often classified as confidential or restricted. This means that the management of such projects must meet the requirements of information security, including the preservation of data, providing control over access to documents and technologies.

For military projects related to the introduction of new simulation technologies or training systems, it is necessary to comply with the safety standards for the use of such systems.

Military project management also often requires interaction with civilian entities such as technology manufacturers or equipment suppliers. This interaction must meet both military standards and general legal norms, including contracts, tender procedures and requirements for the quality of products and services.

Projects implemented within the framework of international cooperation, for example, with the participation of NATO, must meet the requirements for the compatibility of equipment, software and communication systems. This involves compliance with technical and functional requirements to ensure interaction between military units of different countries.

Military projects are often implemented in a dynamic situation, in particular in military conflicts or during operational exercises. Therefore, an important requirement for project management is the ability to quickly adapt to changing circumstances and revise the project plan in real time. This includes, for example, changing training scenarios or requirements for simulators during their implementation.

Examples of regulatory requirements in military projects:

– STANAG 2116 is NATO's system of military ranks, which allows to standardize the ranks of military personnel in different countries for joint operations [13];

– STANAG 6001 – language training standards to ensure operational communication between allies [13];

– STANAG 4586 – standards for the integration of control systems of unmanned aerial vehicles of different countries in military operations [13];

– EXTAC 1000 – extreme tactical instructions for conducting military operations in conditions of increased complexity [14].

4.2.3 IMPLEMENTATION OF FLEXIBLE PROJECT MANAGEMENT METHODOLOGIES (AGILE, SCRUM) FOR MILITARY TRAINING PROGRAMS

Agile project management methodologies, such as Agile and SCRUM, were originally developed for the IT field, but over time, their effectiveness has been recognized in many other industries, including military training. The use of these methodologies in military training programs makes it possible to adapt to rapidly changing circumstances, increase the flexibility of training project management, and ensure a timely response to new challenges and needs [16].

Agile is a project management philosophy based on constant adaptation to change, active communication within the team, and rapid response to the needs of the client or end user. Key principles of Agile include:

– iterative process: the project is divided into short cycles (iterations), each of which ends with the presentation of a certain result;

– flexibility: response to changes in requirements even at late stages of project development;

– constant feedback: regular communication with all stakeholders to quickly adjust plans.

SCRUM is a framework within Agile that structures the team's work through short cycles (sprints), regular meetings and progress evaluation. The main elements of SCRUM are:

– SCRUM Team: a cross-functional team that independently organizes its work;

– Product Owner: the person responsible for maximizing the value of the project and managing the backlog;

– SCRUM master: a team leader who supports the team and promotes adherence to the SCRUM process;

– Sprints: short, well-defined periods of time (usually 1–4 weeks) during which a team completes a set of tasks [17].

Implementation of Agile and SCRUM in military training programs. In the context of military training programs, Agile and SCRUM provide an opportunity to effectively manage projects that include the development of new training modules, the implementation of the latest technologies or the organization of training sessions. Military projects are often highly complex and conditions change depending on operational requirements, so flexibility becomes key.

Military training programs must quickly adapt to new threats, technologies and requirements. The implementation of Agile allows military training centers to quickly make adjustments to the officer training program, integrating new training methods or technical solutions without significant delays.

Agile is suitable for projects that involve gradual development. In the context of military training, this may mean that new simulation technologies or training scenarios can be integrated in stages, allowing instructors and cadets to test and refine them at each stage.

Agile emphasizes constant feedback from end users (military officers, cadets, instructors). This allows to receive timely feedback and adjust training programs to improve their effectiveness.

SCRUM allows to break large training projects into short sprints, during which a team of military instructors or training material developers work on a specific set of tasks. This allows to ensure quick results and improve their quality through regular checks.

The SCRUM framework focuses on completing a certain amount of work during each sprint, which allows to quickly track progress and achieve specific results. For military projects, this means that training programs or simulations can be continuously improved based on the results of previous sprints [17].

4.3 PROJECT PLANNING USING VIRTUAL SIMULATORS

4.3.1 DEVELOPMENT OF A TRAINING PROGRAM FOR NAVIGATION OFFICERS: THEORY AND PRACTICE

The training of naval officers is a critical component of naval education, since the accuracy of their skills and knowledge depends on the success of complex tasks in maritime operations. In the conditions of rapid technological development and changing requirements for military operations, training programs must meet modern standards and be adapted to new challenges. The development of such a program requires a combination of theoretical knowledge with practical experience and the use of modern virtual simulators that allow to reproduce the real conditions of combat operations at sea.

The theoretical part of the training program for naval officers includes basic and specialized disciplines that provide the necessary knowledge for decision-making in complex maritime operations. The basis of the curriculum is the study of the following disciplines:

1. Basics of navigation. Includes the study of the principles of marine navigation, the use of navigational instruments, course calculation, ship management in various weather and seafaring conditions. The theoretical part also includes knowledge about the geography of sea routes and the peculiarities of work in different zones of the sea space.

2. Maritime security. Navigation officers must know the basic principles of ensuring safety at sea, including rules for avoiding collisions, actions in emergency situations, management of emergency and rescue operations. The theoretical part covers international safety standards, in particular SOLAS (International Convention for the Safety of Life at Sea) and COLREG (International Regulations for Preventing Collisions at Sea).

3. Maritime law. Officers must know the basic provisions of the law of the sea, in particular the provisions of the United Nations Convention on the Law of the Sea (UNCLOS), and other international treaties that regulate maritime activities. This helps to ensure correct decision-making in difficult situations in international waters.

4. Crew command and control. Training programs should include disciplines related to effective crew management, task allocation, and decision-making in stressful situations. Officers must have knowledge of the command structure on the ship and the specifics of working with the crew.

5. Analysis of combat operations. Includes a theoretical study of the history of military naval operations, strategies and tactics used during combat operations at sea. This allows officers to analyze mistakes and successes of the past and apply this knowledge in their professional activities.

Practical training is an integral part of the training program for navigation officers. In modern conditions, virtual simulators are an important element of practical training, allowing cadets to gain experience in realistic conditions, simulating real combat and navigation operations.

The use of virtual simulators provides unique opportunities to practice complex maritime operations without the need to go to the open sea, which reduces risks and costs. Here are some key aspects of using virtual simulators in the practical training of navigation officers:

1. Simulators such as VSTEP (NAUTIS) or KILO-VASCO allow to create detailed scenarios of combat operations, where cadets can practice tactical maneuvers, react to threats and follow orders in realistic conditions. This includes simulating weather conditions, enemy actions and interactions with other ships.

2. One of the advantages of virtual simulators is the ability to train cadets in challenging conditions such as storms, limited visibility or complex seabed terrain. This allows cadets to gain experience operating a ship in situations that are hard to recreate in real life.

3. Simulators allow to simulate emergency situations such as fires, ship damage or collisions, which are an important part of practical training. This allows cadets to learn the algorithms of actions in emergency situations and improve their skills in responding to danger.

4. Virtual simulators also provide an opportunity to practice teamwork and coordination of actions between crew members. Through interactive training, cadets can learn to work as part of a team, which is an important element of effective ship management.

Integration of theory and practice. One of the important elements of curriculum development is the integration of theoretical knowledge with practical training. This allows cadets not only to learn the theory of navigation and ship control, but also to apply this knowledge in practice during simulations. For example, after studying the theoretical foundations of navigation, cadets can immediately proceed to practicing the acquired knowledge on virtual simulators, simulating real situations.

An important element of the training program is the assessment of the effectiveness of the training of cadets. Simulators provide an opportunity to perform a detailed analysis of each training session, tracking the errors and progress of the cadets. Instructors can receive detailed information about each stage of training, which allows timely correction of the program and improvement of its quality.

The evaluation system must be integrated into all stages of training and include:

– analysis of completed tasks on simulators;
– feedback from instructors and officers;
– assessment of theoretical knowledge of cadets during tests and assessments;
– regular practical tests simulating various combat scenarios and navigational situations.

4.3.2 DETERMINATION OF THE KEY GOALS AND OBJECTIVES OF THE PROJECT

The project to introduce virtual simulators into training programs for naval navigation officers training aims to create a high-quality, realistic and flexible training environment that will provide cadets with the practical skills necessary to perform tasks in real combat conditions. To achieve this goal, it is necessary to clearly define the key goals and objectives of the project.

The main goals of the project:

1. Improving the quality of training of navigation officers. The main goal is to provide effective training of cadets through the use of virtual simulators that allow simulating complex navigation and combat scenarios. This enables cadets to gain experience in realistic settings without risk to ships or personnel.

2. Optimization of the learning process. The use of virtual simulators allows to reduce the costs of real training, reduce the need to use expensive resources and increase the effectiveness of the training process. It also allows to repeat training scenarios as many times as necessary to achieve the appropriate level of training.

3. Adaptation to modern military requirements. In the conditions of rapid changes in technology and threats, it is important to ensure the flexibility of the curriculum. The project aims to create a training environment that can be easily adapted to new requirements or training tasks that appear in the process of military technology development.

4. Improvement of interaction between military units. With the help of simulation platforms, such as VSTEP (NAUTIS) and KILO-VASCO, cadets have the opportunity to practice joint actions between different military units, which is especially important for multinational operations under the auspices of NATO.

The main tasks of the project:

1. Development of educational scenarios. An important task is the development of realistic training scenarios for simulators that cover a wide range of tasks – from navigational operations to combat operations. This should include different weather conditions, emergency scenarios and possible combat operations at sea.

2. Integration of simulators into educational programs. The project should provide for the full integration of virtual simulators into existing training programs for navigation officers. This includes the development of techniques for using simulators in combination with theoretical classes.

3. Provision of technical support and maintenance. An important task is to create an infrastructure for constant maintenance of simulators and ensuring their uninterrupted operation. This involves the training of technical personnel and the establishment of regular monitoring of equipment performance.

4. Assessment of training effectiveness. The project should include mechanisms for evaluating the effectiveness of training based on the use of virtual simulators. To do this, a system for monitoring the progress of cadets and analyzing the results of training should be developed in order to improve the program based on the received data.

4.3.3 STAGES OF DESIGN: FROM THE INITIAL CONCEPT TO INTEGRATION INTO THE EDUCATIONAL PROCESS

Curriculum design using virtual simulators consists of several key stages, starting with a conceptual vision and ending with full integration into the educational process. Each of the stages requires careful planning and interaction between military instructors, technical specialists and the management of educational institutions (**Fig. 4.5**).

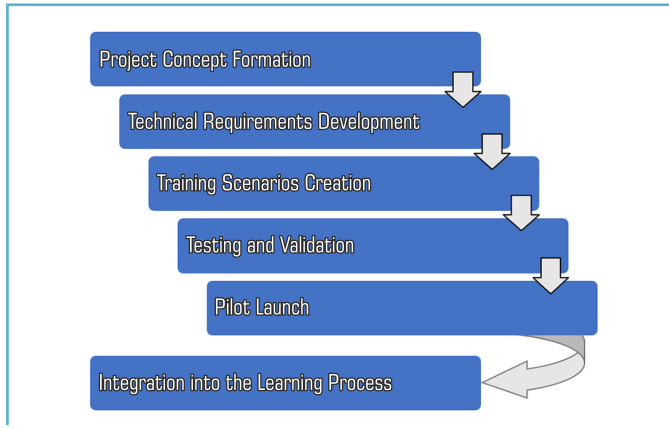

Fig. 4.5 Example of design stages

Stage 1. Formation of the project concept.

The design begins with the development of an initial concept that defines the main directions of the training program, the goals and objectives of the project, as well as the key requirements for the simulation platform.

At this stage, the following aspects are defined:

1. Objectives of the training of navigation officers.
2. Expected learning outcomes.
3. Technical requirements for simulators and equipment.
4. Assessment of necessary resources (human, financial and material).

An important aspect is understanding the specifics of military operations and training tasks that must be reflected in simulators.

Stage 2. Development of the technical task.

At this stage, a technical task is created, which includes all requirements for the development of simulation programs. The technical task defines:

1. Specifications of the equipment necessary for the implementation of the project.
2. Functional capabilities of the simulators to be used.

3. Requirements for educational scenarios.

4. Requirements for the integration of simulators with other educational tools.

Stage 3. Development of learning scenarios.

This stage involves the development of specific training scenarios that will be used in the simulators. Scenarios should reflect a wide range of navigation and combat situations, which will allow cadets to train in different conditions. The main elements of the scenarios are:

1. Simulation of real navigational conditions (weather, currents, seabed landscape).

2. Simulation of combat operations (interaction with the enemy, maneuvers in combat conditions).

3. Working out emergency situations (collision, ship damage, fire, etc.).

Stage 4. Testing and Validation.

After developing simulators and training scenarios, the system is tested. This includes:

1. Checking the functionality of simulators and their compliance with real conditions.

2. Testing different scenarios to ensure their realism and effectiveness.

3. Involvement of instructors and cadets for training and evaluation of the system.

4. This phase also validates the simulators to ensure they meet military requirements and standards.

Stage 5. Pilot launch.

After the testing is completed, a pilot launch of the project is carried out, during which selected groups of cadets are trained on simulators. This allows to get real feedback from users and make the necessary adjustments to the training program. The pilot launch also includes training instructors to work with simulators.

Stage 6. Integration into the educational process.

After a successful pilot launch, simulators are fully integrated into the educational process. This includes:

1. Development of a schedule for the use of simulators.

2. Training of permanent staff for system maintenance.

3. Implementation of the system of evaluation and monitoring of training effectiveness.

4. The integration aims to make simulators a permanent element of the training process, ensuring the continuous training of navigation officers at a modern level.

4.4 RESOURCE MANAGEMENT IN THE PROJECT

4.4.1 HUMAN RESOURCES: INSTRUCTORS, TECHNICAL STAFF AND MILITARY SPECIALISTS

Successful implementation of the project in the field of military training, especially with the use of virtual simulators, requires effective management of resources. This includes the management of both human and material resources that ensure the achievement of the set goals. In this section, let's consider the key aspects of resource management required for the project.

Human resources are one of the most important elements in any project, especially in the field of military training. They include instructors, technical personnel and military specialists who are directly involved in the process of training and maintenance of simulation systems.

The main categories of human resources:

1. Instructors. They play a key role in ensuring quality training of cadets. They are responsible for teaching cadets the basics of navigation, ship control and emergency response. It is important that instructors not only possess theoretical knowledge, but also have practical experience in the maritime field. In addition, instructors should be familiar with the possibilities of virtual simulators and be able to effectively integrate them into the educational process.

The main tasks of instructors:

– preparation of educational materials and training scenarios;

– conducting training sessions on simulators;

– assessment of cadets' training results and feedback.

2. Technical staff. An important element of project management is the technical staff that ensures the proper functioning of simulators and VR equipment. Technicians must have a high level of knowledge in the field of software, VR technologies and simulator maintenance. Their job is to keep the simulation equipment in working order, promptly troubleshoot technical issues, and upgrade systems as needed.

The main tasks of the technical staff:

– installation and adjustment of simulation equipment;

– technical support during training sessions;

– regular updating of software and preventive work with equipment.

3. Military specialists. This is a category of people who are directly trained or are consultants in the process of developing curriculum scenarios. Military professionals provide a hands-on learning experience, sharing their experiences with cadets and helping to adjust training programs to meet the Army's current needs. Often, they also test new simulation scenarios and provide feedback for further improvement.

The main tasks of military specialists:

– consultations on the development of educational programs;

– testing new simulation scenarios;

– evaluation of the effectiveness of training and adjustment of programs.

4.4.2 MATERIAL AND TECHNICAL RESOURCES: SIMULATORS, VR EQUIPMENT, SOFTWARE

Material and technical resources are the basis for the implementation of projects using simulation technologies. These include simulators, VR equipment and software, which are necessary for the effective organization of the educational process.

The main categories of material and technical resources:

1. Simulators. Simulators are the main tool for practical training of navigation officers. They allow to simulate various scenarios, such as navigation in difficult conditions, combat operations or emergency situations. One of the most common simulators in military training is VSTEP (NAUTIS) and KILO-VASCO [3,4,5,6]. They allow to reproduce realistic scenarios with high accuracy and immersion.

The main tasks of simulators:

– simulation of real navigation conditions;

– creation of various scenarios, including emergency and combat situations;

– provision of interactive training for team and individual training.

2. VR equipment. Virtual reality (VR) makes it possible to create even more realistic training conditions, immersing cadets in an environment as close as possible to real combat operations. The use of VR helmets and other devices allows cadets to fully immerse themselves in the learning process, interact with virtual objects and practice tactical maneuvers. VR equipment requires regular maintenance and upgrades to ensure smooth operation.

Main components of VR equipment:

– VR helmets are devices that provide immersion in a virtual environment;

– controllers are tools for interacting with virtual objects;

– motion tracking systems – technologies that allow accurate tracking of cadets' movements in a virtual environment.

3. Software. Software is a critical element in ensuring the efficient operation of simulators and VR equipment. Modern training programs must be integrated with software that allow to create complex scenarios and track the progress of cadets. The software should include a learning management system (LMS) that allows to track the progress of each student and adapt the training programs according to their needs.

The main tasks of the software:

– management of simulation scenarios and control over their execution;

– tracking the progress of cadets and creating reports for instructors;

– update and adaptation of training programs depending on training results.

4.4.3 OPTIMIZATION OF RESOURCES TO ENSURE EFFECTIVE IMPLEMENTATION OF THE PROJECT

Resource optimization is a key factor in the success of any project, especially under tight budget and time constraints. A project to introduce virtual simulators into training programs for naval officers requires careful management of both human and logistical resources to achieve maximum effectiveness.

Optimization consists in ensuring the most rational use of available resources in order to avoid excessive costs, reduce the time for completing tasks and improve the quality of project

implementation. The use of optimization approaches makes it possible to increase the effectiveness of training cadets, reduce maintenance costs and ensure flexibility in achieving project goals.

The main strategies for resource optimization:

1. Rational distribution of human resources. For the effective implementation of the project, it is important to ensure the correct distribution of responsibilities between instructors, technical personnel and military specialists. One of the key tools for this is to create a clear system of responsibilities and tasks for each group of personnel.

Instructors. To optimize their work, it is possible to develop clear training scenarios and materials that allow to reduce the time to prepare for each session. Instructors can work in teams to share responsibility for different stages of the training process, allowing them to focus on specific aspects of the training.

Technical staff. It is important for technicians to establish a clear maintenance schedule for simulators and VR equipment. Optimization of technical maintenance will avoid unforeseen downtimes and ensure smooth operation of the system.

Military experts. Involvement of military experts in the development of training scenarios can be optimized through regular meetings with instructors and technical staff. This will make it possible to quickly adapt training programs to new requirements and reduce the time for developing new scenarios.

2. Use of flexible project management methodologies (Agile, SCRUM). As mentioned earlier in section 4.3, the use of flexible methodologies, such as Agile and SCRUM, allows to optimize the project implementation process due to an iterative approach and constant adaptation to changes. This approach is especially useful for projects that require constant updates and adjustments.

Iterative process. Breaking down the project into separate phases allows the instructor and technical staff to focus on specific parts of the project, which reduces the overall workload and reduces the risk of delays.

Regular meetings and feedback. Thanks to regular SCRUM meetings, the team can make changes in a timely manner, which saves time and resources, without redoing already completed tasks in the final stages of the project.

3. Minimization of costs for material and technical resources. Reducing costs for material and technical resources is an important part of optimization. Several approaches can be used for this:

– lease of equipment instead of purchase. For some projects where the use of certain equipment is temporary, it is advisable to consider the option of renting instead of buying it. This will significantly reduce the cost of technical equipment, especially for expensive VR systems;

– modernization of existing resources. In some cases, modernization of existing equipment can be cheaper and more efficient than purchasing new ones. For projects using simulators, it is worth paying attention to the possibility of updating the software, which will allow expanding the functionality of existing simulation systems;

– using cloud-based solutions. Instead of purchasing expensive servers and data storage systems, it is possible to use cloud-based solutions to store training materials and work with

simulator data. This will significantly reduce infrastructure costs and provide greater flexibility in data access.

4. Use of multifunctional resources. Another approach to optimization is the use of multifunctional resources. This can concern both human resources and material and technical support.

Cross-functional teams. Involvement of instructors and technical staff in joint work allows to increase the efficiency of the project. Instructors can help technicians set up scenarios, and technicians can provide support during training sessions.

Using simulators for different types of training. Optimization is also about making the most of simulators for different training programs. For example, simulators can be used both for the training of navigation officers and for the training of technical specialists or crew, which allows to significantly expand their functionality.

4.5 RISK MANAGEMENT IN THE PROJECT

4.5.1 RISK ASSESSMENT: TECHNICAL, FINANCIAL, ORGANIZATIONAL RISKS

The first step in the risk management process is their assessment. The risks associated with military training projects can vary, but they can be classified into three main categories: technical, financial and organizational [18]:

1. Technical risks. These risks are related to the operation of hardware, software, simulators and VR systems. Since the project involves the implementation of complex technologies, the following technical risks are possible:

– equipment malfunctions: simulators and VR equipment may fail, which may lead to delays in the training process or the need for urgent repairs;

– failure to meet requirements: software or simulation systems may not fully meet technical specifications or expectations;

– cyber security: as simulators may be connected to networks or used online, there is a risk of cyber threats, including unauthorized access to systems or data.

2. Financial risks. Such risks are related to project implementation costs, financing and possible changes in the budget. The main financial risks include:

– budget overrun: project implementation may require more resources than initially anticipated, resulting in overspending;

– unforeseen costs: additional costs related to hardware repairs, software updates or maintenance may occur;

– instability of funding: military projects may depend on government funding, which may be unstable due to economic or political changes.

3. Organizational risks. These risks relate to the internal structure of the project, coordination between teams and the effective management of human resources.

The main organizational risks include:

– lack of qualified personnel: the project may face a shortage of instructors or technical personnel, which delays implementation or reduces the quality of training;

– inadequate coordination: poor interaction between different project units can lead to delays or errors in the completion of tasks;

– time management issues: failure to meet schedules and deadlines due to poor planning or external circumstances (such as tactical or missile strike alert) can significantly affect project success.

4.5.2 DEVELOPMENT OF RISK MANAGEMENT PLANS AND MINIMIZATION OF POSSIBLE CONSEQUENCES

After assessing the risks, it is important to develop risk management plans that include strategies to minimize possible consequences and prevent negative scenarios.

Strategies for minimizing technical risks. Regular maintenance of simulation equipment and VR systems will allow to identify and eliminate potential problems at an early stage. This involves preventive measures, software updates and equipment testing before each training course.

To reduce the risk of equipment malfunctions, it is advisable to provide for the availability of spare equipment or spare parts that can be quickly replaced in case of breakdowns. This will ensure the continuity of the educational process.

And to prevent cyber threats, it is necessary to implement cyber security measures, including installing modern anti-virus programs, encrypting data and restricting access to the network for unauthorized persons.

Strategies for minimizing financial risks. One of the main steps to minimize financial risks is careful budgeting during the project planning phase. It is necessary to anticipate all possible expenses, including contingencies, and ensure a reserve fund to cover unforeseen expenses.

Regular monitoring of expenses allows timely detection of budget overruns and adjustments to plans. It is important that each stage of the project is under constant financial control, which will avoid significant deviations from the budget.

In the case of financial difficulties, it is worth considering the possibility of attracting additional funding from alternative sources or optimizing costs at certain stages of the project.

Strategies for minimizing organizational risks. It is important to provide the project with qualified personnel, in particular instructors and technical specialists. This can be done by training and retraining existing personnel or by engaging external specialists on a temporary basis.

To minimize the risks associated with poor coordination, it is important to establish regular communication between all project participants. This can be achieved by holding regular meetings, exchanging information through corporate systems, or organizing special trainings to increase interaction between departments [19].

The creation of detailed schedules for the execution of tasks and the constant monitoring of their compliance will avoid delays in the implementation of the project. It is worth implementing project management systems that help track progress and ensure transparency of tasks.

It would also be appropriate to create the so-called "Risk Assessment Matrix". The matrix can look like a table (**Table 4.1**), where the probability of risk occurrence is displayed horizontally, and the level of severity of consequences is displayed vertically.

Table 4.1 Risk assessment matrix

Probability/Consequences	Minor (1)	Moderate (2)	Significant (3)	Critical (4)	Catastrophic (5)
Very low (1)	1	2	3	4	5
Low (2)	2	4	6	8	10
Average (3)	3	6	9	12	15
High (4)	4	8	12	16	20
Very high (5)	5	10	15	20	25

Description of categories:

1. Probability (1–5):

1 – Very low (the risk rarely occurs);

5 – Very high (the risk occurs often).

2. Consequences (1–5):

1 – Insignificant (small losses, does not affect the project);

5 – Catastrophic (the risk can lead to significant losses, project stoppage or serious damage).

3. Risk assessment and action:

– high risk (12–25): it is necessary to implement a risk management plan and means for their minimization (additional technical checks, personnel training, equipment redundancy);

– medium risk (6–11): constant monitoring of the situation and readiness to react quickly to risks (cost control, coordination between teams) are required;

– low risk (1–5): requires periodic monitoring but does not require immediate action.

For example, a cyber threat:

1. Probability: 2 (low, subject to compliance with security measures).
2. Consequences: 5 (catastrophic, may lead to loss of important data or system shutdown).
3. Risk score: 10 (high risk, security systems required).

4.5.3 INFLUENCE OF EXTERNAL FACTORS (POLITICAL, MILITARY, ECONOMIC) ON PROJECT IMPLEMENTATION

External factors such as political, military and economic changes can significantly affect the implementation of the project.

These factors are often unpredictable and can have both positive and negative consequences for the progress of the project:

1. Political factors. The political situation can affect the financing and general direction of the project. Changes in government priorities or political instability can lead to:

– changes in funding: political decisions can affect the project budget, including reductions in government funding or its reallocation;

– changes in defense strategy: political changes may affect changes in a country's military strategy, which in turn may require adjustments to training programs or technological approaches in a project.

2. Military factors. Military operations and combat can directly affect training projects, especially if the training of naval officers is related to real combat needs:

– emergency mobilization of personnel: in the event of hostilities or threats, instructors or cadets may be mobilized to participate in military operations, resulting in the delay or suspension of training programs;

– changes in military priorities: military conflicts may require urgent adjustment of training programs to adapt to new threats or tactical requirements.

3. Economic factors. The economic situation in the country or at the international level can also affect the project:

– inflation or economic crises: economic instability can lead to an increase in the prices of equipment and services, which will affect the financial condition of the project;

– reduction of public expenditures: in the event of an economic crisis, the state may reduce expenditures on defense projects, which may affect the pace of their implementation or even lead to a freeze.

4.6 ASSESSMENT OF PROJECT EFFECTIVENESS AND QUALITY CONTROL

4.6.1 DETERMINATION OF PROJECT SUCCESS CRITERIA

Effective implementation of a project using virtual simulators for the training of navigation officers requires constant quality control and evaluation of results. Evaluating the effectiveness of the project makes it possible to determine how successfully the set goals have been achieved, and to adjust further actions to improve the level of preparation. Quality control is a critical element that allows to ensure the appropriate level of preparation and compliance of the project with established standards.

Project success criteria are key indicators that determine how well the project meets the initial goals and objectives. These criteria vary depending on the specifics of the project and the expected results, but in general, several main categories can be distinguished for training projects using simulators.

The main success criteria:

1. Achieving learning goals in accordance with training standards – learning outcomes. The main criterion for success is the project's ability to ensure the achievement of defined educational goals. This includes training cadets to perform complex tasks at sea, improving their navigation skills and combat readiness. The curriculum must meet the requirements of naval standards and ensure that cadets have acquired the necessary knowledge, skills and abilities.

2. Compliance with quality standards. The success of the project is also determined by its compliance with established quality standards, in particular international standards for the training of maritime officers, such as STCW (International Convention on Standards of Training, Certification and Watchkeeping for Seafarers). Training programs must meet these requirements, and simulation technologies must provide a realistic and effective experience for cadets.

3. Effective use of resources. The success of the project is also measured by the efficiency of the use of human and material and technical resources. This includes optimal staffing, proper simulator maintenance, and cost minimization.

4. Satisfaction of participants. An important criterion is the satisfaction of cadets and instructors. High quality of training, realistic scenarios and ease of use of simulators are indicators of a successful project. Feedback from participants allows to assess the overall level of satisfaction and identify opportunities for further improvement.

5. Continuity of the training process. The success of the project can also be judged by how seamless and seamless the integration of simulators into the learning process is. The project is considered successful if training takes place without significant technical interruptions and the equipment functions stably.

4.6.2 METHODS OF ASSESSING THE QUALITY OF NAVIGATION OFFICER'S TRAINING

Assessment of the quality of training of navigation officers is an important component of the project. For this, various methods are used, which allow to check how effective the training programs are and how well the cadets acquire knowledge and skills.

The main methods of assessing the quality of training:

1. Testing of knowledge, skills and abilities. One of the main methods of evaluation is the testing of cadets to check their theoretical training and skills. Tests may cover topics in navigation, maritime law, maritime safety and crew command. It is important that the testing is adapted to the training level of the cadets and corresponds to the goals of the training program.

2. Practical tests on simulators. Practical tasks, which are performed on simulators, make it possible to assess the level of practical training of cadets in realistic conditions. Cadets can perform tasks related to navigation in difficult weather conditions, emergency situations or combat operations. The assessment is based on the analysis of their actions, decisions and speed of response to changing factors.

3. Error analysis and feedback. After each practical session, an analysis of the mistakes made and feedback from the instructors is carried out. This allows the cadet to understand his/her mistakes and practice correct decisions in subsequent sessions. Feedback helps to improve not only the learning process, but also the instructors themselves in their teaching methods.

4. Monitoring progress. Learning management systems (LMS) allow instructors to constantly monitor the progress of cadets. Such systems store the results of tests, evaluations of practical tasks and general progress, which allows to get a complete picture of the level of training of each cadet.

5. Graded assessments and credit modules. Evaluation of the effectiveness of training can be carried out on the basis of a system of rating evaluations and credit modules. This allows to compare the results of different cadets and identify the strengths and weaknesses of the training program [20].

4.6.3 ANALYSIS OF RESULTS AND CONCLUSIONS REGARDING THE EFFECTIVENESS OF VIRTUAL TRAINING

The last step in the process of evaluating the effectiveness of the project is the analysis of training results and conclusions about the impact of virtual simulators on the training of navigation officers, which should cover several aspects.

The main aspects of the analysis of the results:

1. Comparison of results with initial goals. First of all, the analysis of training results should be aimed at comparing the achieved indicators with the initial goals of the project. This makes it possible to determine to what extent the training program using simulators meets expectations and whether the required level of officer training has been achieved.

2. Assessment of cadets' progress. It is important to analyze the progress of cadets at each stage of training. This gives an idea of how effective each session and scenario was in the simulators. Progress analysis helps identify possible problems in the training program and make timely adjustments to improve efficiency.

3. The impact of virtual simulators on the educational process. One of the key aspects of the analysis is the assessment of the impact of virtual simulators on the quality of training. This includes examining how realistic and effective the simulation scenarios were, how well the cadets responded to them, and whether they improved their readiness for real-world tasks at sea.

4. Cost effectiveness analysis. To assess the overall effectiveness of the project, it is also important to conduct a cost-benefit analysis. This allows to find out whether the investment in the project was justified in view of the achieved educational results. If the educational goals were achieved with lower costs, this indicates a high efficiency of the project.

5. Assessment of participants' satisfaction. Equally important is the assessment of the level of satisfaction of cadets and instructors. If the participants of the training process highly appreciated

the quality of training, the realism of the simulations and the convenience of the equipment, this indicates the success of the implementation of virtual technologies.

Conclusions on the effectiveness of virtual training. Analysis of the results can show significant advantages of using virtual simulators in officer training. The main advantages include the possibility of safely working out complex scenarios, increasing the realism of training, flexibility and reducing costs.

The analysis also allows to identify possible weaknesses or aspects that can be improved. For example, it is possible to improve training scenarios, add more options for the development of events, or improve the user-friendliness of simulators.

Depending on the results of the analysis, it is possible to draw conclusions about how effective the introduction of virtual simulators into the educational process will be in the long term. If educational goals are consistently achieved and the quality of training improves, this indicates the feasibility of further use of such technologies.

4.7 PROJECT DEVELOPMENT PROSPECTS AND FURTHER STEPS

4.7.1 POTENTIAL FOR PROJECT EXPANSION: NEW SIMULATIONS, INTERNATIONAL COOPERATION

The project using virtual simulators for military training has significant potential for expansion both nationally and internationally. This opens up opportunities to create new simulation scenarios and expand cooperation with other countries, in particular through alliances such as NATO.

Military training programs can be significantly expanded through the introduction of new combat simulations. These can be scenarios simulating modern threats such as cyber-attacks, unmanned operations or operations in complex geographic environments. Expanding the library of simulation scenarios will allow cadets to practice new types of tasks and prepare for operations in new conditions.

An important area of expansion of the project is the development of scenarios for joint operations with other military units or military branches. For example, simulations involving interaction between naval, air and land forces will allow cadets to practice coordination of actions in multinational or intergenerational operations.

In addition to combat scenarios, virtual simulators can be used to prepare for peacetime operations such as humanitarian missions, maritime rescue operations, anti-piracy and security in international waters.

International cooperation. Implementation of joint training programs with NATO member countries allows not only to improve the level of training of cadets, but also to ensure their ability to work effectively as part of international military coalitions. Joint simulations will allow cadets to learn to interact with military units of other countries and practice operations according to uniform standards.

International cooperation opens opportunities for the exchange of technologies and best practices in the field of military training. Countries can jointly develop new simulation systems, exchange experience in the use of artificial intelligence in simulators, and create joint innovative projects.

4.7.2 INNOVATIVE APPROACHES TO IMPROVING VIRTUAL MILITARY TRAINING

Innovative technologies and training approaches open new horizons for improving the virtual training of military officers. Modern technologies make the educational process more realistic, effective and adaptive:

1. Integration of adaptive learning technologies. One of the areas of development is the creation of adaptive scenarios that automatically adjust to the level of knowledge and skills of the cadets. This will make it possible to provide an individual approach to each cadet and provide him/her with tasks that correspond to his/her level of training, gradually increasing the complexity of the tasks.

To improve the realism of training, it is possible to implement simulations that simulate stressful situations and test the psychological readiness of cadets to work in extreme conditions. This can be particularly useful for training officers who will direct operations in a combat environment.

2. Use of augmented reality (AR). Augmented reality (AR) can become an important element in the training of military officers. With the help of AR, it is possible to create interactive educational materials that complement real scenarios with virtual objects. This will allow cadets to learn on real objects, while using virtual prompts, additional information and other elements that will help them make the right decisions.

3. Gamification of the educational process. Gamification, that is, the use of game elements in education, allows to increase the motivation of cadets and make the educational process more interactive. Creating rating systems, difficulty levels, and game achievements can help cadets learn better and engage more actively in learning [21].

4.7.3 USE OF ARTIFICIAL INTELLIGENCE AND NEW TECHNOLOGIES IN SIMULATIONS FOR OFFICERS TRAINING

Artificial intelligence (AI) plays an important role in modernizing the simulation systems used in military training. The use of AI opens up new possibilities for creating more realistic, flexible and adaptive simulations.

Artificial intelligence in enemy simulation. Using AI to simulate enemy behavior allows to create more realistic and dynamic scenarios. Intelligent algorithms can control virtual opponents who change their tactics depending on the actions of the cadets, making simulations more unpredictable and effective for practicing tactical skills.

The use of AI in educational systems allows the creation of self-learning simulations that analyze the actions of cadets and adapt scenarios based on their decisions and mistakes. This allows each cadet to go through an individual learning path, which increases the quality of training.

Application of AI to analyze cadets' actions. Real-time analysis of training results AI can be used to automatically analyze the actions of cadets during simulations. AI-based systems can assess cadets' reactions, tactical decisions and actions, providing instructors with detailed reports on training outcomes. This allows to quickly identify weak points and provide recommendations for further improvement.

Modern simulation systems can use AI to continuously monitor and evaluate the progress of cadets. AI analyzes their actions during training and adjusts scenarios to deepen certain skills. This approach allows to increase the individual effectiveness of training and helps each cadet to achieve a high level of professional training.

CONCLUSIONS

The project on the implementation of virtual simulators will significantly improve the process of training for navigation officers. The use of simulations will allow to better master the skills of managing a ship, improve teamwork, increase the level of readiness for real combat tasks, and also reduce training costs. Thanks to the introduction of the latest technologies (VR, artificial intelligence), the educational process will become more interactive and adaptable to the individual needs of cadets.

The results of the implementation of virtual simulators in the educational process indicate several key achievements:

1. Improvement of practical skills of cadets. Virtual simulators will allow cadets to practice realistic scenarios of maritime operations in safe conditions. This will significantly increase their level of readiness to perform real tasks, providing a deeper understanding of complex navigational and tactical processes.

2. Reduction of costs for real training. The use of simulators will minimize training costs, including fuel, ship maintenance, and the organization of real training missions. This will help save resources and make the educational process more effective.

3. Reduction of risks during preparation. Simulating dangerous situations such as accidents, combat operations and natural disasters will allow cadets to learn how to act in crisis situations without risking their lives or the lives of the crew. Thanks to this, training will become safer and more productive.

4. Integration of the latest technologies. The introduction of virtual reality (VR), artificial intelligence (AI) and other innovative technologies will make the educational process more interactive and flexible. Cadets will have the opportunity to undergo individual training programs that allow taking into account their personal needs and level of knowledge.

The use of simulators will improve the professional training of cadets, increase their ability to make decisions in crisis situations, and also help to better prepare for modern threats and challenges. Training programs will become more dynamic and flexible, which will positively affect the readiness of the military to perform complex tasks.

Expanding simulation scenarios will better prepare officers for various types of operations, including multinational missions.

The integration of artificial intelligence will help to adapt training to the needs of each cadet, and will also increase the realism of combat scenarios. International cooperation will ensure the exchange of best practices and allow cadets to prepare for joint operations as part of international coalitions.

The project will have a positive long-term impact on the level of training of military personnel and will create a foundation for the further development of military training programs.

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