

ADAPTING SPECIALIZED MILITARY VEHICLE TECHNOLOGY TRAINING TO THE EDUCATIONAL NEEDS OF THE CURRENT GENERATION

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Abstract: *The article addresses a current topic in military training, namely the development of technical competencies for managing tank systems and military vehicles within bachelor's-level education. The approach considers scalability both at the level of military organizations and, to some extent, within civilian educational organizations. The general methodological framework is provided by a comparative analysis of two training paradigms, referred to as classical and modern. The research question and, subsequently, the research objectives refer to identifying the most effective forms of knowledge acquisition for achieving training goals that are strongly correlated with current security and societal challenges in the specified field of activity. The main conclusion of the article recommends a mixed approach that combines techniques, tools, and methods specific to both paradigms analyzed.*

Keywords: training paradigms, simulation-based training, competencies, practice, technical skills

1. Introduction

Technological developments over the past few decades have transformed the way military training activities are designed and conducted. The complexity of modern technical systems, the high level of automatization, and the interdependence between operational and digital components demand the development of advanced skills starting from the initial training phase at the bachelor's-level. Traditional training methods, which rely primarily on the structured teaching of knowledge and standardized practical exercises, require the use of digital solutions, simulation platforms and extended reality technologies [1].

The scientific literature shows that training environments based on simulation allow the accurate reproduction of complex operational situations, reducing the costs and risks associated with real-world training and facilitating the acquisition of skills through

direct experience [2, 3]. These technologies, also, help increase learner engagement and improve knowledge retention, particularly in fields that require rapid responses and decision-making under conditions of uncertainty and technical complexity.

For military vehicles, technical training involves the integration of skills, including knowledge of how equipment operates under various operational conditions, the ability to diagnose malfunctions, the use of information systems for logistics support management, and the operational integration of activities. These requirements go beyond the traditional framework of training and necessitate the development of flexible training model capable of responding to technological advancements and current operational requirements.

The objectives of the research are:

- determining the systemic, technical, and operational characteristics of traditional training methods;

- identifying the benefits of a new approach based on modeling and simulation solutions and the integration of experiential learning activities;
- conducting a comparative analysis between the traditional and modern paradigms.

2. Research resources and methodology

2.1. Resources used in the research

The research was based on an analysis of specialized literature in the field of technical training, the use of simulation technologies, and the development of professional competencies in complex operational contexts. Studies addressing the impact of digital technologies on the training process, the role of simulation in developing practical skills, and the principles of experiential learning were analyzed, all of which are considered relevant to personnel training.

The bibliographic resources used include scientific articles, empirical studies and research reports that highlight how simulation-based training environments contribute to the development of technical skills and enhance the safety of the training process. Recent studies show that the use of simulators enables the repetition of exercises under controlled conditions and reduces risks associated with real-world training, particularly in fields involving a high level of responsibility [3, 4]. Virtual environments allow the development of practical skills in a safe environment, without compromising the integrity of the equipment or the safety of the personnel involved in the training.

The research also examined studies addressing the principles of experiential learning and the role of active learner engagement in the educational process. In the current context, characterized by digitalization and automatization, literature highlights the need to adapt training programs to technological trends and to the complexity of modern technical systems [5].

2.2. Research methods

To achieve the proposed objectives, the research used methods specific to technical

education and specialized professional training in the field of security and defense, namely literature review, comparative analysis, and conceptual synthesis.

The documentary analysis focused on the review of specialized literature regarding the use of simulation technologies in technical training and the development of professional competencies, contributing to the theoretical foundation of the research.

Comparative analysis was used to evaluate the differences between the classical and modern training paradigms, considering the characteristics of the training process, the role of technology, and the development of practical skills.

The conceptual synthesis facilitated the integration of the findings and the formulation of conclusions regarding the effectiveness of training methods in the field of military engineering, leading to the development of a conceptual model that combines traditional and modern training methods.

2.3. Criteria for analyzing and comparing training paradigms

To conduct a comparative analysis of the two training paradigms, criteria were established that reflect the main characteristics of the technical training process and the operational requirements of modern military systems. These criteria were selected based on the relevant literature and practices used in the field of professional training.

The criteria used in the analysis are:

- the effectiveness of the training process;
- the level of realism of the environment;
- the safety of the training process;
- implementation and operating costs;
- the ability to adapt to technological advancements;

3. Results and discussion

3.1. Current characteristic of training methods in the military technical field

Training processes in the field of military tank and vehicle systems are influenced by increasing technological complexity and the

integration of information and communications technology (ICT) applications into operational activities. Modern systems include interdependent mechanical, electronic, and software components, which require the development of multidisciplinary skills and the continuous adaptation of training methods to current technological requirements.

Traditional training methods in the military technical field are characterized by the rigorous structuring of training activities and the direct use of equipment for environments with a high level of operational stability (primarily non-hybrid solutions and kinetic operations). These methods ensure the development of the fundamental skills necessary for the operation and maintenance of technical systems. The main characteristics of traditional training methods include:

- training organized around standardized programs and operational procedures;
- structured delivery of theoretical knowledge through lectures and demonstrations;
- direct use of actual equipment to perform practical activities;
- application of technical procedures under controlled training conditions;
- use of technical documentation as the primary source of information and guidance for activities;
- repetition of exercises to reinforce skills and reduce execution errors;
- performance evaluation based on the correct execution of procedures and knowledge.

3.2. Benefits of integrating modeling, simulation, and *learning by doing*

The integration of modeling and simulation technologies into the training process helps increase the effectiveness of training and develop practical skills. The use of simulation in an Extended Reality (XR) context allows for the repetition of exercises under conditions varying in intensity and operational complexity and reduces the risks associated with operating real equipment,

particularly in fields involving hybrid technological systems (mechanical, electrical, electronic, chemical, etc.) and versatile tactical responsibilities.

A key benefit of using simulation is the increased engagement of trainees in the training process. Virtual environments facilitate active learning and allow for the practice of technical scenarios that cannot be frequently replicated in real-world conditions. In addition, simulation offers the possibility of objectively evaluating performance and quickly identifying operational errors [1, 4].

The concept of *learning by doing* is a fundamental principle of professional training in the technical field [6]. It involves acquiring skills through direct participation in practical activities and by applying knowledge in real-world work situations. In the field of military technical systems, this approach contributes to the development of analytical, diagnostic, and decision-making skills under conditions of uncertainty. The concept has also been applied at the individual level, with an example presented at the EDT 2026 conference for armored vehicle technology, combining manufacturing elements with operational requirements replicated on a reduced scale.



Figure 1: Demonstration of the “learning by doing” principle using small-scale equipment.

Source: [7]

To highlight the relationship between instructional methods and the level of information retention, literature frequently uses the conceptual model known as the Learning Pyramid [8]. This model suggests

that the level of learning increases as learners actively participate in the instructional process and directly apply the knowledge they have acquired.

The learning pyramid illustrates those passive methods, such as reading or lectures, result in low information retention, while active methods, such as simulations, hands-on exercises, and teaching other learners, help reinforce skills and increase the effectiveness of the training process.

3.3. Comparative analysis of training paradigms

A comparative analysis of classical and modern training paradigms highlights significant differences in how the training process is organized and how technical skills are developed.

Classical paradigm relies on theoretical instruction and the use of actual equipment to develop practical skills. This approach ensures direct familiarity with equipment and operational procedures but involves high costs and limitations regarding the repetition of exercises.

Modern paradigm uses digital technologies and simulators to develop technical skills and replicate operational situations [3], [4]. This approach allows an increased flexibility in the training process and quick adaptation to technological developments.

For example, the Ukrainian Armed Forces are using VARJO XR-4 technology for training with the Leopard 2 A4 MBT system [9].



Figure 2: Usage of XR technology.
Source:[9]

To summarize the differences between the three training models, the main characteristic of the classical paradigm, the modern one, and an integrated model has been analyzed in a comparative approach as detailed in Table 1.

Table 1. Comparative analysis of training paradigms based on established criteria

Analysis criteria	Classical paradigm	Modern paradigm	Integrated Model
Efficiency of the training process	Moderate	High	High
Level of realism of the training environment	High	High	High
Safety of the training process	Medium	High	High
Implementation and operating costs	High	Moderate	Optimized
Capacity to adapt to technological developments	Low	High	High

The analysis indicates that the two paradigms should not be treated as alternatives, but rather as complementary approaches. Integrating classical and modern methods can optimize the training process and build the skills needed to operate complex and technical systems, and for this reason, it is important to combine these methods in an optimal balance.

3.4. Integration of formative assessment methods and its implications for development of technical skills

The integration of traditional and modern training methods is essential for developing technical skills in the field of modern military systems. This integration allows trainees to take advantage of the strengths of each method and adapt the training process to current operational requirements.

The integrated training model involves the combined use of theoretical instruction, practical activities, and simulation to develop professional competencies. This approach contributes to increasing the effectiveness of training and developing the ability to operate in complex conditions.

A public study conducted by PricewaterhouseCoopers (PwC) highlights significant differences between traditional methods and training based on immersive technologies, reporting increases in confidence levels of up to 275%, a learning speed four times faster, a concentration level four times higher, and an emotional connection approximately 3.75 times greater, as presented in table 2 [10].

Table 2. Results of virtual reality on training effectiveness[10]

Indicator	Value	Description
Confidence after training	275%	Greater confidence in applying knowledge gained in the course
Training speed	4x	On average, faster results compared to traditional courses
Focus level	4x	Greater attention than in the case of e-learning programs
Emotional engagement	3.75x	More emotionally engaged with the subject matter than students in the classroom

4. Integrated training model for the development of technical skills

4.1. The conceptual framework of the integrated training model

The proposed integrated training model describes the process of developing technical skills as a sequence of progressive levels of training, where each stage is associated with a specific type of activity and an observable level of performance [11]. The model is structured in four main levels:

- understanding the system;
- following procedures;
- resolving technical issues;
- working independently in real-world conditions.

These four levels must be addressed in

integrated manner, within the context of weapons systems, given their dependencies and interdependencies of a technical, systemic, and operational nature.

The logic of the model consists in the direct correlation between training and current activities in the operational environment, so that the training process mirrors the actual structure of technical tasks. In this way, progress is determined not only by the ability to perform concrete tasks at a defined level of performance. This approach allows a coherent structure of training, a clear assessment of skill levels, and the gradual integration of accumulated experience and expertise into activities specific to the military technical field.

The application of the model provides operational benefits by progressively structuring training, reducing errors in the execution of procedures, and increasing the predictability of technical performance. Furthermore, the model facilitates the adaptation of the training process to the actual requirements of operations and maintenance activities, as each stage is defined based on specific tasks.

4.2. Stages of the training process in the integrated model

The training process within the integrated model is structured in successive stages, each one playing a distinct role in the development of technical competencies. The sequence of stages, as illustrated in figure 3, reflects the increasing complexity of training activities and the growing operational autonomy of trainees [12].

The first stage involves acquiring fundamental knowledge regarding the structure and operation of technical systems. This stage includes understanding operating principles, identifying technical components, and becoming familiar with standard operating and maintenance procedures.



Figure 3: Stages of the training process in the integrated technical instruction model.
Source: author

The second stage refers to applying knowledge in controlled practical activities during which technical procedures are practiced and operating conditions specific to technical systems are simulated. These activities are designed to develop operational skills and reduce execution errors.

The third stage requires the use of simulators to replicate complex technical situations, in which operational scenarios are analyzed, and trainee's reactions are evaluated under variable operating conditions. In this stage, competencies related to diagnosing faults, decision-making, and managing critical situations are developed.

The final stage of the process integrates the acquired skills into operational activities, where real equipment is used and technical procedures are applied under conditions specific to the work environment [13].

4.3. Aligning the integrated model with the development of technical skills

The integrated training model allows for a direct link between operational requirements and the technical skills developed during the training process. Each stage of the process

contributes to the development of a specific set of skills, and progress is determined by the ability to perform technical tasks under defined conditions.

The development of technical competencies can be described as a gradual process, in which the level of performance increases as training stages are completed and practical experience is consolidated. This evolution reflects the transition from conceptual knowledge of technical systems to their effective use in operational situations.

The integrated model allows the training process to be adapted to the complexity of technical systems and the dynamics of the operational environment, ensuring the development of the competencies necessary for the operation and maintenance of modern equipment.

5. Implementation framework and future directions for development

5.1. Structure of the training model implementation process

Implementing the integrated training model involves organizing training as a sequence-based process, in which activities are aligned with the operational requirements of

technical systems. The process is structured into distinct stages, ensuring the continuity of training and the progressive development of competencies [14].

The first stage consists of identifying the technical requirements and the types of tasks specific to operation and maintenance activities. Therefore, competency levels and the corresponding activities are defined.

The second stage involves organizing training activities according to the complexity of the technical systems and the sequence of technical operations. The activities are structured to reflect actual work processes and the operational

workflow of the equipment.

The final stage involves assessment of performance by evaluating the ability to perform technical tasks under defined conditions. The results obtained make it possible to determine the level of competence and identify the next steps in the training process.

For a better understanding of how the implementation stages are applied, the following table presents technical requirements, specific types of tasks, and competency levels related to activities carried out in the field of armored vehicle systems

Table 3. Examples of how to apply the steps in the training model implementation process.

Source: Author

Process stage	Technical requirements	Types of specific tasks	Competency level	Training activities
Requirements identification	Knowledge of the power unit structure	Identifying engine components	Level 1 – Know	Analysis of the technical diagram and description of system operation
	Knowledge of the fuel supply system	Locating the fuel pump		Identifying components on the equipment
	Knowledge of the electrical system	Recognizing elements in the circuit		Interpreting an electrical diagram
	Use of technical documentation	Consulting the operating manual		Study of technical documentation
Training organization	Application of maintenance procedures	Replacing the fuel filter	Level 2 – Execute	Performing the procedure according to instructions
	Use of workshop equipment	Disassembling a mechanical assembly		Practical exercise on equipment
	Application of inspection procedures	Checking the oil level		Performing periodic technical inspections
Training organization	Diagnosis of mechanical systems	Identifying a mechanical fault	Level 3 – Solve	Analysis of a technical situation
	Diagnosis of electrical systems	Locating a fault in the circuit		Use of measuring instruments
	Analysis of technical parameters	Interpreting operating values		Comparing values with standard parameters
	Determining the intervention method	Selecting the technical solution		Making the technical decision
Performance evaluation	Performing complete tasks	Performing routine maintenance	Level 4 – Operate autonomously	Performing a simple inspection
	Operation of technical systems	Preparing the vehicle for the mission		Inspection of the overall technical condition
	Management of technical systems	Troubleshooting a malfunction in the		Diagnosis and technical intervention

Process stage	Technical requirements	Types of specific tasks	Competency level	Training activities
		field		
	Reporting results	Preparation of a report		Documentation of the intervention
	System functionality check	Testing the equipment after repair		Confirmation of operation within specifications

5.2 Trends in the development of the training model in the field of military technical training

The evolution of technical systems and the increasing levels of automatization, digitalization, cyber-physical integration and virtualization characteristic of Industry 5.0 are driving changes in how the training process is organized and in the types of skills required for the operation and maintenance of equipment [15].

In the long term, the development of digital technologies and the increasing complexity of technical systems will lead to the expanded use of training environments based on technical scenarios and the integration of assessment methods focused on operational performance.

The proposed integrated training model can be regularly improved by updating activities in line with technological changes and the operational requirements of technical systems. This ensures consistency of the training process and prepares trainees to operate modern equipment.

6. Conclusions

The paper shows that developing technical competencies for the management of military vehicles takes place in a context characterized by technological complexity and increasing interdependence between technical and operational components. Given that, traditional training methods continue to form the basis of professional training, as they ensure the development of fundamental knowledge and skills necessary for the optimal execution of technical procedures.

The comparative analysis indicates that the

development of technical competencies cannot be addressed through the separate use of various training methods, but rather by organizing them into a process structured around progressive levels of competency. The proposed integrated model describes professional training as a sequence of stages directly correlated with the technical activities carried out in operations and maintenance units, from understanding the functioning of systems and executing standard procedures to resolving technical issues and operating equipment autonomously.

Applying this structure allows a clear organization of the training process and an objective assessment of the competency level, based on the ability to perform technical tasks under defined conditions. Linking instructional activities with real-world operations helps increase the relevance of training and narrows the gap between theoretical preparation and the practical demands of operating technical systems.

Looking ahead, the development of the training process in the military technical field is driven by the evolution of technological systems and the need for continuous adaptation of training activities to operational requirements. In this context, the integrated training model can be used as a framework for organizing training, which allows maintaining the coherence of the educational process and the progressive development of the technical competencies necessary for the operation and maintenance of modern equipment.

The role of military institutions of higher education as well as post-secondary

education (particularly the warrant officer's program) is a defining one in the verification, validation, and accreditation of the proposed model. The establishment of requirements regarding which learning outcomes are to be achieved and at what level (quantification of learning outcomes) must be aligned with such a model.

Regarding future research directions in this field, the training approach proposed by NATO, named *Audacious Training* presents an interesting perspective. It is based on goal-oriented training, adaptability, controlled risk-taking, and rapid decision-making. All aspects of this approach rely on the use of the latest technologies [16].

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