

The Impact of Extended Reality (XR) Training for Military, Police, and Enterprise

Key Findings from the German Army VIRTUOS Study
and Supporting Research

WHITE PAPER

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INTRODUCTION

XR TRAINING – WHITE PAPER

Revolutionizing Training Through Immersive Technology



This white paper explores the transformative impact of Extended Reality (XR) technologies in military, police, and security training. By leveraging immersive simulations and advanced feedback mechanisms, XR offers significant advantages in preparing personnel for real-world operational challenges. Drawing from comprehensive insights from field tests with the German Army, industry studies by HTC and PwC, and extensive research from HOLOGATE, we present a detailed overview of how XR reshapes training paradigms by enhancing operational readiness and offering substantial cost benefits.

In addition to real-world applications, the paper delves into the underlying cognitive principles, which form the foundation of how XR technologies improve learning outcomes. These principles demonstrate how XR environments allow trainees to mentally reconstruct and rehearse scenarios, infer missing information in complex settings, and intuitively process visual data, all of which are critical in high-pressure situations.

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The VIRTUOS Study

STUDY ON THE USE OF VR BY THE GERMAN ARMY

In 2020, the German Army launched a comprehensive study to evaluate the use of Virtual Reality (VR) systems in military training, specifically utilizing the HOLOGATE HGXR platform. This advanced VR system supports a wide range of military and law enforcement training scenarios, accommodating multiple users simultaneously in spaces ranging from 20 to 1,000 square meters. This flexibility allows for a diverse set of exercises to be conducted in varied environments.

The HOLOGATE HGXR system provides a versatile training environment that integrates seamlessly with military-grade equipment, including firearms and advanced systems like anti-tank shoulder-mounted devices. This capability makes it highly effective for simulating realistic tactical military exercises and specialized law enforcement operations. The system's software allows instructors to easily customize scenarios, manage controls, and conduct detailed after action reviews.



WTD 91

HOLOGATE conducted the VIRTUOS study together with the "Wehrtechnische Dienststelle 91" of the German Army.



METHODOLOGY

Over the course of the study, around 100 participants were questioned after experiencing the VR training. These individuals provided detailed feedback on key aspects of the training, including comfort, level of immersion, motion constraints, and the overall effectiveness of the XR training system in enhancing military preparedness. The participants' feedback helped evaluate how well the VR system met the demands of real-world military operations.

The data presented in this report is based on the feedback and performance evaluations gathered from the participants. It is an excerpt from the study and only highlights a portion of the answers that are relevant to the structure of this paper. By concentrating on the broader insights and benefits of XR training, this report offers a clear view of how XR technologies can enhance training programs and better prepare soldiers for the complexities of modern combat.

Key Learnings

Enhanced Realism in High-Stress Scenarios XR training offers unparalleled realism, especially in high-stress situations, by simulating intense, high-risk environments such as close-quarter battles, severe injuries, and even death. This realism equips trainees with the situational awareness needed for real-world combat. Beyond physical simulation, XR engages trainees emotionally and psychologically, helping them better manage the mental stress associated with actual combat.

Comprehensive Environmental Simulation XR's ability to simulate complex environments is another key strength. It allows training in specialized settings that are difficult to access in real life, such as aircraft, or critical infrastructure. This adaptability provides diverse practice environments, like accurately replicated embassies, offering realistic contexts for operations that require precision and sensitivity.

Safe Handling of Sensitive Scenarios XR excels in safely simulating complex scenarios involving children, animals, large crowds, or hazards like explosions and smoke, without real-world risks. Additionally, XR helps manage ethical dilemmas and civilian interactions under pressure, fostering better decision-making. It also removes the need for stringent safety precautions required in live training.

Tactical and Technical Proficiency In terms of tactical training, XR provides detailed scenarios for practicing maneuvers such as navigating through smoke, shooting through barriers, and utilizing cover. The system's capacity for repetition allows trainees to repeatedly run the same scenarios, a crucial element in mastering maneuvers and refining group strategies for real-world application.

Realistic Interaction with Role Players XR enables realistic interactions through role-players who autonomously engage with trainees, and it supports force-on-force training, where trainees engage in tactical exercises against each other in simulated combat. This enhances both individual and team skills.

Customization and Resource Efficiency XR's ability to rapidly customize training scenarios without additional costs allows instructors to adapt environments on the fly, continuously challenging trainees in evolving situations. This adaptability not only maximizes engagement but also reduces logistical burdens by eliminating the need for travel, live ammunition, and extensive setup.



SUMMARY

XR provides a comprehensive, dynamic, and efficient training platform that enhances realism, ensures safety, improves tactical proficiency, and reduces costs.

General Data

Quality and Comfort Ratings

The comfort of the VR equipment was rated highly by the majority of participants, with 88% reporting it as either very good or good. Most users also felt they could move freely within the VR system, with 76% reporting no motion constraints and 24% experiencing only slight limitations in movement.

In terms of immersion, the quality provided by the VR system was rated very positively, with 94% of participants describing the experience as very good or good. Furthermore, the issue of motion sickness was minimal, with 86% of users reporting no symptoms, and only 14% experiencing slight discomfort during the sessions.

73% agreed or strongly agreed that the VR training improved their ability to handle real-world scenarios.

77% found that VR was highly suitable for unique and complex scenarios that are difficult to replicate in real life.

84% believed the VR system provided significant value, particularly in terms of evaluation & feedback capabilities.

100% VR is effective for developing psychological competencies such as mental strength & stress reduction.



97%

Very good or good

Collaborative experience that facilitates teamwork

85%

Highly beneficial

To understand critical procedures, aiding their comprehension



Key Findings

Overwhelming responses and improvements over traditional training



IMPROVEMENTS OVER TRADITIONAL TRAINING

Participants felt that the VR training offered substantial improvements over existing training methods, highlighting the system's overall enhancement of traditional approaches.



SHOULD BE MADE AVAILABLE NOW

Participants expressed their recommendation for the VR system and unanimously agreed that this technology should be made available for future training purposes.



Now is the Time to Invest in VR

Overall, these findings suggest that VR technology, provides significant improvements to traditional training methods. It enhances practical skills, fosters improved teamwork, and offers unique training opportunities that are difficult to replicate through conventional methods, making it a valuable addition to training programs. The evidence from the responses clearly demonstrates that VR is ready for large-scale deployment in training programs.

Implementation

Considerations for Success

Implementing VR training requires careful attention to various factors that influence its effectiveness and impact. A strategic approach ensures that the technology delivers meaningful results while avoiding common challenges. This section outlines the key considerations for successfully integrating VR into training programs. By addressing these factors, organizations can unlock the full potential of immersive learning environments.

Cognitive Load

VR environments are highly immersive and dynamic, with constantly changing scenes and situations that can impose a high cognitive load on participants. To avoid overwhelming trainees and hindering learning outcomes, it is crucial to design scenarios with proper pacing and balance to prevent cognitive overload.

Negative Training Effects

A key risk in VR training is the potential for negative training effects, where incorrect behaviors or habits might be learned. To mitigate this, a well-structured and robust training curriculum must be developed specifically for VR. This includes identifying which skills are best suited for VR training and which might not be appropriate for this format.

Content Suitability

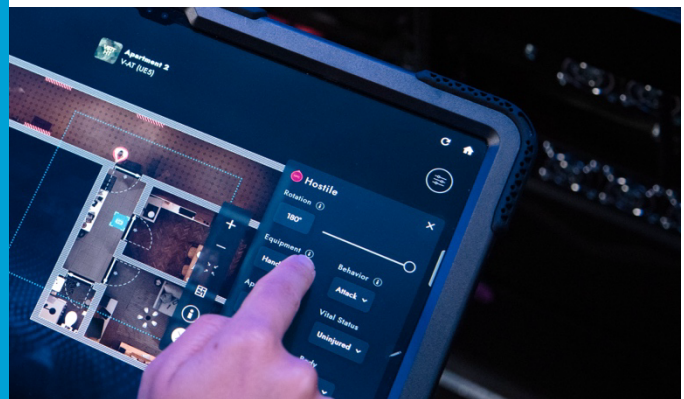
Not all training content is ideal for VR.

Questions to consider include:

What types of content are best delivered through VR?

Which content is unsuitable for VR-based training?

What kinds of training materials are optimally suited?



Technological Limitations

Understanding the technological constraints of VR systems is essential. These limitations may involve hardware capabilities, software stability, user interface complexity, and the physical space required for safe and effective use of the system.

Operational Requirements

Implementing VR training typically requires dedicated operators and trainers to manage the system and ensure smooth operation. This includes handling the technical setup, troubleshooting, and overseeing the effectiveness of the training sessions.

The ability of VR to simulate real-world environments and situations with high fidelity is unparalleled.

It's a game-changer for training.

— Sundar Pichai, CEO Google

Future Prospects

Artificial Intelligence

Extended Reality technology is not only leading the way in current training methodologies but also holds tremendous potential for future advancements that could further revolutionize education and training. As VR technology continues to evolve, we anticipate improvements in several key areas, including, greater visual fidelity, more precise tracking, and sophisticated user behavior through AI. Digital human twins are already being developed to model realistic behaviors.

Motion Simulators

HGXR is actively expanding its training solutions to include XR motion simulators for vehicles, aircraft, and boats, significantly enhancing the realism of piloting and driving in various environments. These simulators can also integrate weapons systems, allowing trainees to practice handling equipment such as machine guns, grenades, and heavy weaponry, further increasing the scope and depth of training exercises.

Biometric Feedback

Moreover, ongoing research at HOLOGATE is exploring the use of biometric feedback to monitor stress levels in real-time. This data allows the training environment to dynamically adapt based on the trainee's physiological responses, providing an even more tailored and effective learning experience. By integrating AI and biometric data, future VR training systems will be capable of delivering highly personalized and responsive training sessions, optimizing the learning process for everyone.

Networked Environments

This expansion facilitates multi-domain joint forces training by enabling complex, coordinated exercises across land, air, and water through networked XR environments. Trainees in different locations can participate in synchronized operations, such as helicopters landing special forces, creating a fully integrated and immersive experience that fosters joint mission readiness and seamless coordination between military branches.

A New Generation

Appeal and Engagement

VR is also proving particularly popular among digital-native generations, who are accustomed to dynamic, interactive experiences in their everyday lives. This demographic's comfort and familiarity with digital tools make VR an attractive option for training programs. For instance, a YouTube video demonstrating the German Army's VR capabilities has garnered over 290,000 views, reflecting significant interest and engagement from a tech-savvy audience. This interest highlights VR's potential not only to meet the current needs of digital-first trainees but also to enhance the appeal and effectiveness of training across various sectors.

Motivation and Effectivity

By leveraging the digital competencies of younger generations, VR bridges the gap between traditional training methods and the expectations of tomorrow's professionals. It ensures that training programs are not only effective but also engaging and aligned with trainees' preferences for technology-driven learning environments. Modern training programs, particularly those using cutting-edge VR technology, should aim to be both engaging and motivating. Incorporating elements of gamification and emphasizing hands-on, experiential learning rather than theoretical instruction can dramatically improve both the effectiveness and enjoyment of the training experience.



Trainees of the German Army are utilizing the MBDA Enforcer integration in XR training for a realistic anti-tank scenario.

Notably, 85% of participants reported that the VR training was “fun.” Gamification transforms learning into a competitive, interactive experience, enhancing motivation and significantly improving knowledge retention. By allowing trainees to apply concepts in practical, real-world scenarios, VR maximizes educational impact while creating a proactive, enthusiastic learning environment.

Further Validation

Cross Industry Validation

To further validate the advantages of XR in military training, we incorporate key findings from HTC and PwC studies. HTC's exploration of XR within U.S. military branches, and PwC's analysis of VR's impact on corporate training, both align with our research, reinforcing XR's effectiveness in improving training.



By drawing parallels between these independent studies and our own, we build a compelling case for the broader adoption of XR technologies. The consistent benefits observed across different sectors, from military to corporate, highlight XR's transformative potential in modern training strategies.

Insights from HTC's Study

"The State of Extended Reality (XR) Training within the U.S. Armed Forces Overview and Key Findings"

HTC's whitepaper highlights the growing role of Extended Reality (XR) in U.S. military training, emphasizing the shift towards immersive simulation-based systems. XR's capability to create hyper-realistic environments that mimic the unpredictability of real-world operations has driven widespread adoption. The immersive nature of XR improves learning retention by allowing trainees to experience scenarios from various perspectives, with real-time feedback accelerating skill acquisition.

The white paper is available here:

<https://business.vive.com/us/stories/vr-military-use-2023-survey/>

About HTC - HTC VIVE is the premier extended reality (VR/XR) platform and ecosystem that creates true-to-life VR/XR experiences for businesses and consumers. The VIVE ecosystem delivers premium VR/XR hardware, software, and content. VIVE Business encompasses best-in-class VR/XR hardware and software and solutions.



HTC's Insights

A survey of 400 military trainers and procurement specialists across the U.S. armed forces found that 80% believe XR enhances educational plans and empowers coordinators to deliver more effective programs.



Preparedness for Stressful Situations

67% of respondents reported that XR training significantly helps them better prepare for stressful and high-pressure situations, enabling them to react more calmly and efficiently in real-world scenarios.



Confidence and Muscle Memory

81% of respondents noted that XR increases their confidence and helps in cultivating the necessary muscle memory, ensuring that skills are deeply ingrained for effective real-world application.



Preparation for Real-World Situations

77% of respondents stated that XR training significantly helps prepare them for dangerous real-world situations, providing a safe yet immersive environment in which they can practice critical tasks and responses.



Adoption and Implementation Plans

75% of respondents who are not currently using XR stated that they plan to implement XR-based training solutions by 2028, reflecting a growing recognition of the technology's potential to revolutionize training.



Speed of Training Completion

76% of respondents mentioned that XR allows trainees to complete training programs more quickly, reducing the time required to achieve proficiency without compromising the quality of learning.



Recruitment and Retention Advantage

74% of respondents said that the implementation of XR training gives their organization a recruitment edge by attracting tech-savvy talent, while 70% stated that XR helps retain top talent by offering cutting-edge training opportunities.

PwC's Insights

“What does Virtual Reality and the Metaverse mean for Training?”

PwC's study on VR training highlights its transformative effect on the learning landscape. Key findings show that employees trained with VR complete sessions much faster compared to traditional or e-learning methods, enabling quicker deployment of skills in the workplace. VR also significantly boosts confidence and engagement, as employees report feeling more connected to the content—particularly valuable for developing soft skills like empathy and communication.

Virtual Reality significantly enhances training by improving focus, engagement, and efficiency. While the initial costs of implementing VR can be higher, it becomes highly cost-effective as the number of trainees increases, making it an excellent long-term investment.



Available here:

<https://www.pwc.com/us/en/tech-effect/emerging-tech/virtual-reality-study.html>

4X FASTER

Learning Efficiency

VR-trained employees complete training up to four times faster than those in traditional classroom settings.

150% more Focus

Focus Enhancement

Learners stay four times more focused than those in e-learning settings and 1.5 times more focused than in traditional classrooms.

375% more Emotional Engagement

VR learners felt 3.75 times more emotionally connected to the content than those trained in classrooms. This emotional engagement is critical for deeper learning and retention.

275% Confidence Boost

Employees trained using VR reported being up to 275% more confident in applying what they learned compared to those trained through traditional methods.

Cost-Effectiveness at Scale

Although VR has a higher upfront cost, it becomes more economical as the number of participants grows. VR training matches the cost of classroom learning at 375 learners and e-learning at 1,950 learners, with the cost savings increasing as more people are trained.

A Cognitive Framework

Top 10 Cognitive Principles

Throughout HOLOGATE's years of experience in XR training with the military, police, and the VR gaming industry, valuable insights have been gained into the cognitive principles that drive the effectiveness of XR content. These principles serve as foundational elements for shaping future training methodologies.

By leveraging the following principles, XR enhances learning, decision-making, and spatial awareness, particularly in high-stress environments such as military, law enforcement, and emergency services. The following ten key principles illustrate how XR improves training outcomes and prepares individuals for the complexities of real-world operations.

01

Mental Reconstruction: Strengthening Decision-Making

Mental Reconstruction allows individuals to mentally simulate tasks and replay sequences of actions. XR enhances this ability by providing immersive, repeatable environments where trainees can practice complex tasks, such as urban combat or high-risk law enforcement scenarios. The repeated mental rehearsal enabled by XR helps individuals develop the muscle memory and decision-making skills needed to act quickly and accurately under stress.



02

Amodal Completion: Inferring Missing Information

Amodal Completion refers to the brain's ability to infer information in situations where parts of the environment are hidden or obscured. XR places trainees in scenarios where they must make quick inferences—such as a soldier identifying enemy locations behind obstacles or a firefighter locating victims in a smoke-filled room. By repeatedly engaging with these environments, trainees learn to anticipate threats and make decisions even when key information is missing.



03

Gestalt Principles: Organizing Complex Visual Data

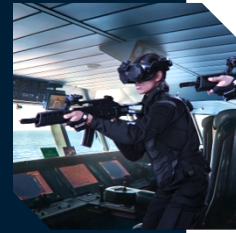
The Gestalt Principles explain how the brain organizes visual information, helping individuals quickly recognize patterns and group elements in chaotic environments. XR leverages these principles by immersing trainees in complex visual scenarios, such as disaster scenes, where quick categorization of threats or priorities is critical. Practicing these skills in a virtual setting improves trainees' ability to process complex information rapidly.



04

Embodied Cognition: Enhancing Learning Through Physical Interaction

Embodied Cognition posits that learning is most effective when the body is actively involved in the process. XR training incorporates haptic feedback and full-body tracking, allowing trainees to physically interact with the virtual environment. Soldiers can experience the weight of a weapon, the resistance of terrain, or the impact of cover during combat. This physical engagement helps reinforce motor skills, muscle memory, and situational awareness, making it easier to transfer skills from virtual to real environments.



05

Active Learning: Increasing Engagement and Retention

Active Learning involves engaging learners directly in the learning process through hands-on participation and interaction. XR fosters active learning by immersing users in dynamic scenarios that require real-time decision-making, strategy development, and physical interaction. Whether it's a soldier coordinating team tactics or a police officer responding to an unfolding threat, XR ensures trainees are active participants rather than passive observers, resulting in deeper learning and better retention.



06

Spaced Repetition: Reinforcing Long-Term Retention

Spaced Repetition is a learning technique where concepts or skills are reviewed at increasing intervals to improve long-term retention. XR systems can incorporate spaced repetition by revisiting key scenarios and skills over time. Trainees can repeatedly practice critical operations, such as battlefield tactics or rescue missions, at intervals that optimize retention. This method helps ensure that knowledge and skills are retained longer and can be easily recalled in real-world situations.



07

Cognitive Load Theory: Balancing Complexity and Efficiency

Cognitive Load Theory suggests that learning is most effective when cognitive demands are balanced with the learner's working memory capacity. XR can adjust the complexity of scenarios to suit the learner's current ability, gradually increasing difficulty as trainees master foundational skills. By managing cognitive load, XR prevents trainees from becoming overwhelmed while ensuring they are continually challenged. This adaptability makes XR a powerful tool for progressively building expertise in complex, high-stakes environments.



08

Transfer of Learning: Applying Skills Across Contexts

Transfer of Learning is the ability to apply knowledge or skills learned in one context to another. XR excels at fostering this transfer by closely simulating real-world conditions. Soldiers who train in XR environments experience realistic conditions—such as battlefield chaos or tactical urban operations—allowing them to seamlessly apply the skills learned in simulation to real missions. This capability makes XR especially effective in preparing individuals for diverse and unpredictable real-world challenges.



09

Flow State: Optimizing Focus and Performance

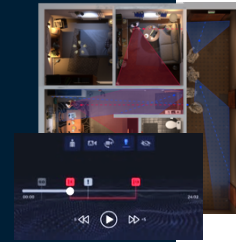
The Flow State is a mental condition in which individuals are fully immersed in a task, leading to optimal performance and learning. XR can facilitate flow by creating highly engaging, immersive environments where trainees are focused entirely on the task at hand. Whether in a high-intensity combat simulation or an emergency response scenario, XR's immersive nature can help trainees enter the flow state, resulting in improved focus, skill development, and performance.



10

Data Analytics and Feedback: Continuous Performance Improvement

Though not traditionally categorized as a cognitive principle, Data Analytics and Feedback are integral to the effectiveness of XR training. Advanced XR systems track performance metrics such as reaction time, accuracy, and decision-making processes. This data is used to provide immediate feedback and after action reviews, helping trainees identify strengths and areas for improvement. By incorporating data analytics, XR ensures continuous performance.

**Conclusion: Enhancing Spatial and Dynamic Decision-Making with XR**

The combination of these ten cognitive principles makes XR a powerful tool for preparing individuals for high-stakes, complex environments. Through **Mental Reconstruction**, trainees repeatedly practice decision-making sequences, while **Amodal Completion** teaches them to act on incomplete information. **Gestalt Principles** help them process complex visual data, and **Embodied Cognition** ensures that physical engagement enhances learning. XR's ability to foster **Active Learning**, **Spaced Repetition**, and **Transfer of Learning** ensures that knowledge is retained and applied effectively in real-world settings. By carefully managing **Cognitive Load**, XR allows trainees to master increasingly complex tasks without becoming overwhelmed, while the **Flow State** enhances focus and performance. Lastly, **Data Analytics** provides a feedback loop for continuous improvement.

Together, these principles create a comprehensive framework for effective XR training, enhancing both **spatial awareness** and **dynamic decision-making**. Whether in military operations, law enforcement activities, or emergency responses, XR ensures that personnel are fully prepared to navigate the complexities and unpredictability of their real-world missions.

Conclusion

Final Summary

Transforming Training with XR

This white paper consolidates extensive data and insights to highlight the transformative impact of Extended Reality (XR) in military and law enforcement and enterprise training. Based on comprehensive studies conducted by the German Army and supported by research, the findings consistently demonstrate the significant advantages of XR technologies across a wide range of training scenarios.

These benefits extend beyond military use. HOLOGATE's collaboration with law enforcement, such as German and Swiss Police, demonstrates that XR's advantages also apply to police training. Whether simulating routine patrols or complex crisis responses, XR mirrors the success seen in military settings by improving decision-making, enhancing safety protocols, and increasing tactical readiness in law enforcement operations.

The effectiveness of XR is also evident in enterprise training, where it enhances employee skill development in areas like technical proficiency, safety protocols, and soft skills. XR enables companies to create highly immersive, interactive learning environments that improve engagement, retention, and real-world application of skills. From onboarding to advanced training, XR offers a scalable and adaptable solution that prepares employees for the complexities of modern business challenges, making it a valuable tool across industries.

HOLOGATE remains committed to pushing the boundaries of XR innovation, working closely with experts and technologists to advance the possibilities of training simulations. The goal is not only to meet the evolving demands of security and defense but also to set new standards for training efficiency and effectiveness.



If you're looking to develop a powerful and efficient XR training program, we're here to assist. [Reach out to HOLOGATE + HGXR](#) today to explore how our advanced hardware, software solutions, and adaptable implementations can elevate your training across various sectors. Whether for defense, law enforcement, or enterprise, our expertly designed integrations are built to enhance training outcomes and equip your team for future challenges.

About HOLOGATE + HGXR

HGXR offers cutting-edge extended reality (XR) solutions for training and simulation and is a division of HOLOGATE, the market-leading immersive media company specializing in innovative XR solutions for entertainment and enterprise. With the largest VR network worldwide, our unforgettable virtual experiences and solutions are transforming the way the world entertains, trains, and simulates. We are pioneers at the forefront of innovation, uniquely tailored for the age of spatial computing, with an established track record of industry recognition.

With HGXR systems, any real situation can be simulated, visualized, and trained in the virtual space. We offer end-to-end XR solutions that guarantee full flexibility in terms of space and usability while offering the latest XR technology, high-end graphics and a growing app library - efficient, effective, and multifunctional in use. Based in Munich, we boast a team of 80+ employees and a management board with expertise in engineering, real-time media and military. Our clients include the German Army and the police.

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