VR Team Training for military special forces

Frank Jaspers
Technical Test Center for
Weapons and Ammunition
Meppen, Germany
FrankJaspers@bundeswehr.org

ABSTRACT

The presentation "VR Team Training for Militäry Special Forcesd" provides an overview of the implementation of the study “VirTUOS – VIRtual Training of Urban Operations as a multi-user scenario”. Together with future users, a VR demonstrator / VR training system for team training was set up at the Technical Test Center in Meppen/ Germany (WTD 91). In an iterative approach, the demonstrator was specifically adapted to military use using test subjects. The presentation provides, an overview of the implementation path of the study, the current state of development and the convincing study results.

Another focus of the presentation are the identified advantages of team training in VR compared to classic training methods. The final point of the presentation illustrates further possible applications as well as the existing and expected development potential for future applications, such as improving VR training through the use of AI or reaction training with weapons in VR.

ABOUT THE AUTHOR

Frank Jaspers learned the profession of communications electronics engineer at the Technical Test Center for Weapon and Ammunitions in Meppen / Germany. After working in the areas of telecommunications technology and ergonomics as well as software ergonomics, he built up the AR, VR and MR department and is now head of the department. With the establishment of the department, he can pursue his passion. The department carries out practical R&D studies to create new XR applications. The result is, among other things, an action trainer for the team training of special forces of the German Army or an XR application for visualize virtual units in real terrain for the training of the Joint Fire Support Team.
In addition to his role as XR department head, he is project manager for the first digital shooting range for live shootings and also responsible for R&D related to live fire systems.

Future Combat Training System – improved live fire training by digitalization

Frank Jaspers
Technical Test Center for Weapons and Ammunition
Meppen, Germany
FrankJaspers@bundeswehr.org

BACKGROUND

Whenever digitalization is discussed, virtual reality is at the forefront. Advertising agencies have discovered young people wearing head-mounted displays (HMD) on their heads and controllers in their hands. But what chances and opportunities does the use of this technology offer the German Army? The Augmented, Virtual and Mixed Reality department at the Technical Test Center for Weapons and Ammunitions (WTD 91) deals with this question and finds answers.

INTRODUCTION

Virtual Reality (VR) is a currently available technology for particularly realistic representation and intuitive interaction in computer-generated, synthetic simulation environments. In this way, a high degree of the user's sense of presence in the synthetic environment is achieved, so that certain situations are perceived as convincingly real. It is expected that with the help of these technologies a high level of training and performance of military personnel can be achieved.

FREE SPACE VR

WTD 91 conducts studies in the field of virtual reality in order to develop new applications for the Bundeswehr. The main focus here is on the application and not the technology as such. Within the recently completed research and technology study "VirTuOS - Virtual training of urban operations as a multi-user scenario", the demonstrator "Virtual Action Trainer (VirtAT)" was set up in an iterative approach closely involving the future user. The demonstrator is an open-space VR application in which four soldiers can move and train freely as a team on an area of 200m². The area of an old vehicle hall was transformed into a modern free space VR environment (Figure 1).

Figure 1: Free space VR environment at the WTD 91

In the 200m² area each individual person is recorded by a total of 96 infrared cameras attached to a truss system. The visualization data is streamed via WiFi to the HMD, the so-called VR glasses. In order to receive feedback from the VR world, the test subject wears a haptic vest which, among other things, signals an enemy hit by triggering a vibration. To increase situational awareness, an electrical feedback device can also signal a hit (Figure 2).

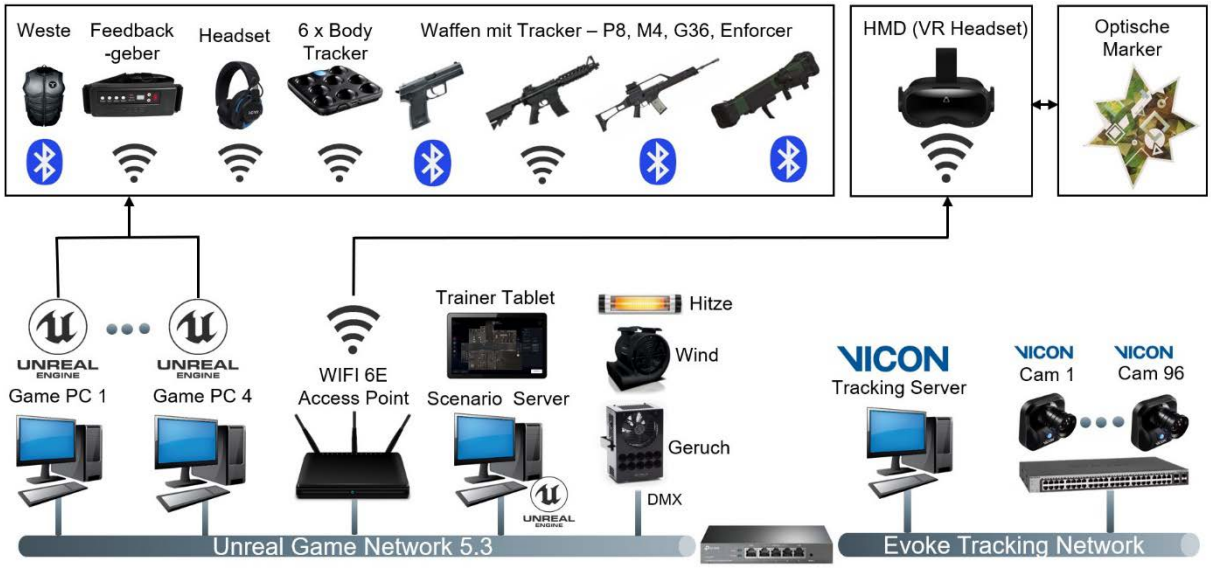

Figure 2: System structure of the "Virtual Action Trainer" – expansion stage 2024

While game controllers are used in the home environment, in the "Virtual Action Trainer" realistic replicas of hand weapons such as G36, P8 and M4 are used as controllers. To increase realism, all weapon replicas have a recoil system. The soldiers communicate acoustically via a separate headset. The trainer can communicate with each individual person as well as with the whole group. Numerous views from the VR environment are available for analyzing the

training. Additional information such as the weapon line, the field of view or the security status of the weapons can also be displayed. The use of heat maps enables the trainers to get a quick overview of whether the trainees have checked all the necessary rooms during their training missions.

You can currently practice on over 25 virtual training maps, including apartments, a hotel lobby, an Eastern European street with a walk-in building, subway stations, a school, an airplane, a gas station, a four-story bank and residential building complex, or a ship's bridge, to name just a few. The number of training maps is continuously being developed and their number is constantly increasing.

CONDUCTING TEST SUBJECT EXAMATIONS

In order to determine the usability and weaknesses of the system, as well as its technological limitations, three test subject examinations were carried out within this study with a total of 112 subjects from the area of specialized and special forces as well as operational forces of the Federal Police (Figure 3). The results of the respective subject examinations were analyzed and evaluated in order to adapt and expand the system in a results-oriented manner. This approach resulted in targeted and risk-minimized research.

Figure 3: A test subject opens a virtual door during the test subject examination

RESULTS OF THE TEST SUBJECT EXAMINATION WITH THE VIRTUAL ACTION TRAINER

A wealth of reliable results could be achieved through the test subjects' examinations. A number of advantages were also identified. The evaluation of the investigations revealed the following important statements, among others

- Training in VR does not replace real training. Rather, it expands existing training and thus closes training gaps through the use of technology

- The virtual action trainer is an asset for the training, as it allows, among other things, safe training in dangerous situations. In addition, situations that are difficult to represent in reality can be trained in VR, such as the reaction to attacking dogs or people with explosive belts
- The VR-supported training has been met with consistently high user acceptance. All participating test subjects would like to use a similar VR system for future training
- VR technology offers training content without limitations as it offers a variety of training scenarios. Training can be carried out in places that are generally difficult to access, such as crowded places or inaccessible objects.
- The otherwise frequent occurrence of simulator sickness / cyber sickness in VR is almost non-existent in the virtual action trainer
- The system allows for a very high sense of presence with a high degree of realism. The user is immediately immersed in virtual reality.
- No training system offers more evaluation options: the ongoing exercise can be viewed from any position. In addition, an after-action review (AAR) can be carried out through digital recording after the exercise has been completed. With the AAR it is possible to comprehensively analyze the entire exercise process. Through the evaluation, errors are identified more easily and can therefore be corrected more quickly.

SYSTEM USABILTY SSCALE (SUS)

On of the tests at every of the three large subjects' examinations was the System Usability Scale (SUS). The System Usability Scale (SUS) was invented by John Brooke who, in 1986, created this ‘quick and dirty’ usability scale to evaluate practically any kind of system. The SUS has been tried and tested throughout almost 30 years of use, and has proven itself to be a dependable method of evaluating the usability of systems compared to industry standards.
The System Usability Scale is a Likert Scale which includes 10 questions which users of your website will answer. Participants will rank each question from 1 to 5 based on how much they agree with the statement they are reading. 5 means they agree completely, 1 means they disagree vehemently.

The ten template questions are:
I think that I would like to use this system frequently.
I found the system unnecessarily complex.
I thought the system was easy to use.
I think that I would need the support of a technical person to be able to use this system.
I found the various functions in this system were well integrated.
I thought there was too much inconsistency in this system.
I would imagine that most people would learn to use this system very quickly.
I found the system very cumbersome to use.
I felt very confident using the system.
I needed to learn a lot of things before I could get going with this system.

This means that each question placed next to the Likert scale will look as figure 4:

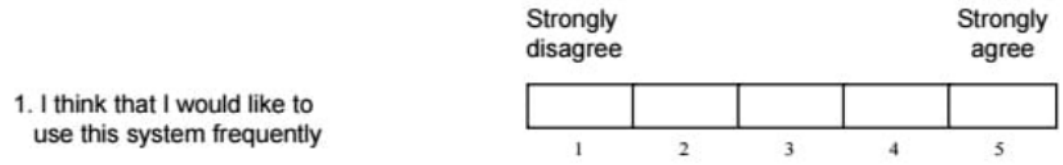

Figure 4: Question of the SUS Test

The System Usability Scale is not diagnostic and will not tell you what specific problems you face, but it will give you a red or green light to know how badly your usability needs work.
The average System Usability Scale score is 68 and the maximum score is 100. If your score is under 68, then there are probably serious problems with your application usability which you should address. If your score is above 68, then you know your application is being developed in the right direction.

The SUS questionnaire was completed by the soldiers who used the system as trainees. The great results are shown below in Figure 5:

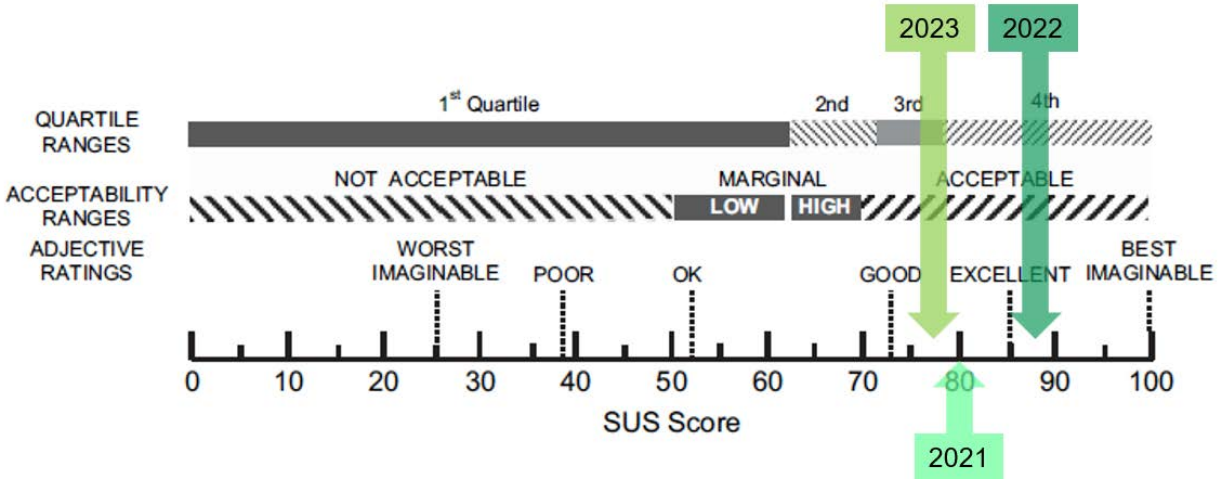

Figure 5: SUS results trainee VirtAT

The trainer also completed the SUS questionnaire. The trainer's survey began in 2022, as the VirtHT was only a technical demonstrator in 2021. The results are shown below in Figure 6:

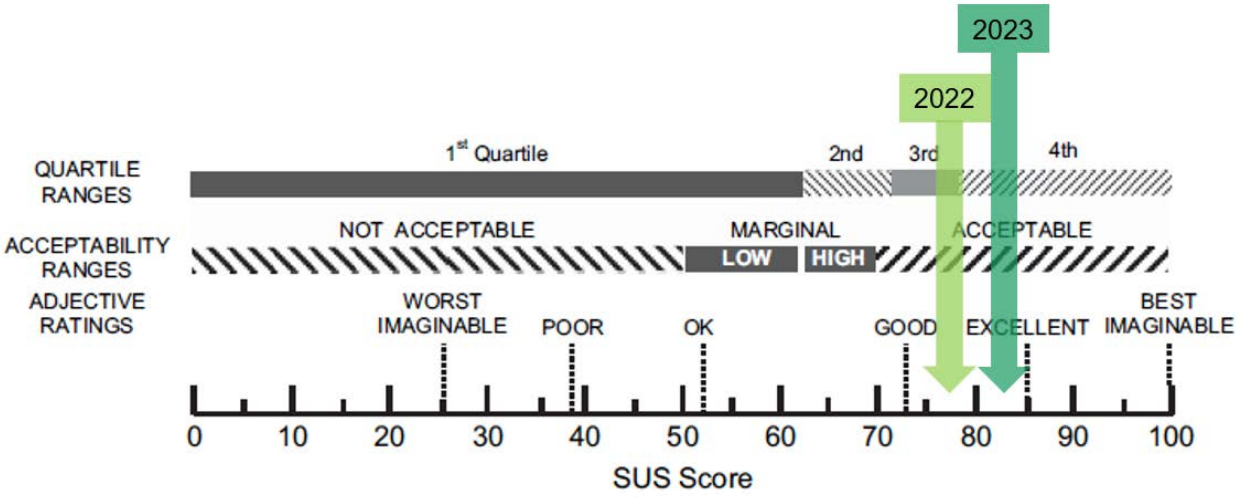

Figure 6: SUS results trainer VirtAT

From year to year the results the SUS score increased, except the SUS score from the trainees in 2023. The reasons for the poorer result in 2023 were logical and understandable:

- Switch to Unreal Engine 5 and the resulting errors paired with the short time for error correction until investigation
- More complex systems often lead to a poorer result in the SUS test.
  Questions such as:
  - I had to learn a lot of things before I could work with the system
  - I find the system easy to use
- Poor condition:
  - High temperatures between 25 - 30 degrees Celcius
  - Poor air due to insufficient ventilation / air exchange

FINAL DEMOSTRATION

At the final demonstration of the R&D study in March 2024 at WTD 91, the possibilities of VR technology were presented to a broad audience, consisting of interested representatives from the German Federal Ministry of Defense, Federal Office of Bundeswehr Equipment, Information Technology and In-Service Support, the specialized and special forces, as well as from the police sector. The high level of interest in the use of VR technology in the Bundeswehr was also evident throughout the entire duration of the study: numerous high-ranking Bundeswehr officials obtained an overview of the study results and tested the system themselves (Figure 7). The study has undoubtedly sparked interest in VR technology in the Bundeswehr.

Figure 7: Head of the Armaments Department, Vice Admiral Stawitzki, in a virtual firefight

In addition, the positive results of the study will be directly transferred to procurement, starting with troop trials at the six locations of the specialized and special forces. Improvements in system stability and robustness should be achieved by the scheduled procurement in 2025.

UNIVERSAL VR SIMULATION PLATFORM

The "Virtual Action Trainer" is more than just a training system for team training of specialized and special forces, as many other applications can be implemented using the platform. During the course of the study the following additional applications were implemented:

- Anti-tank training
  The “Light weight weapon system 1800+”, which is currently being introduced, was integrated into the system. The weapon system can be used to combat virtual tank targets. The functional sequences of actions are implemented true to the original. This system integration of a guided missile system impressively demonstrated the rapid implementation of a system that has not yet been introduced into a training

environment. Accordingly, the VR platform is suitable for the early on development of new weapon systems (Figure 8).

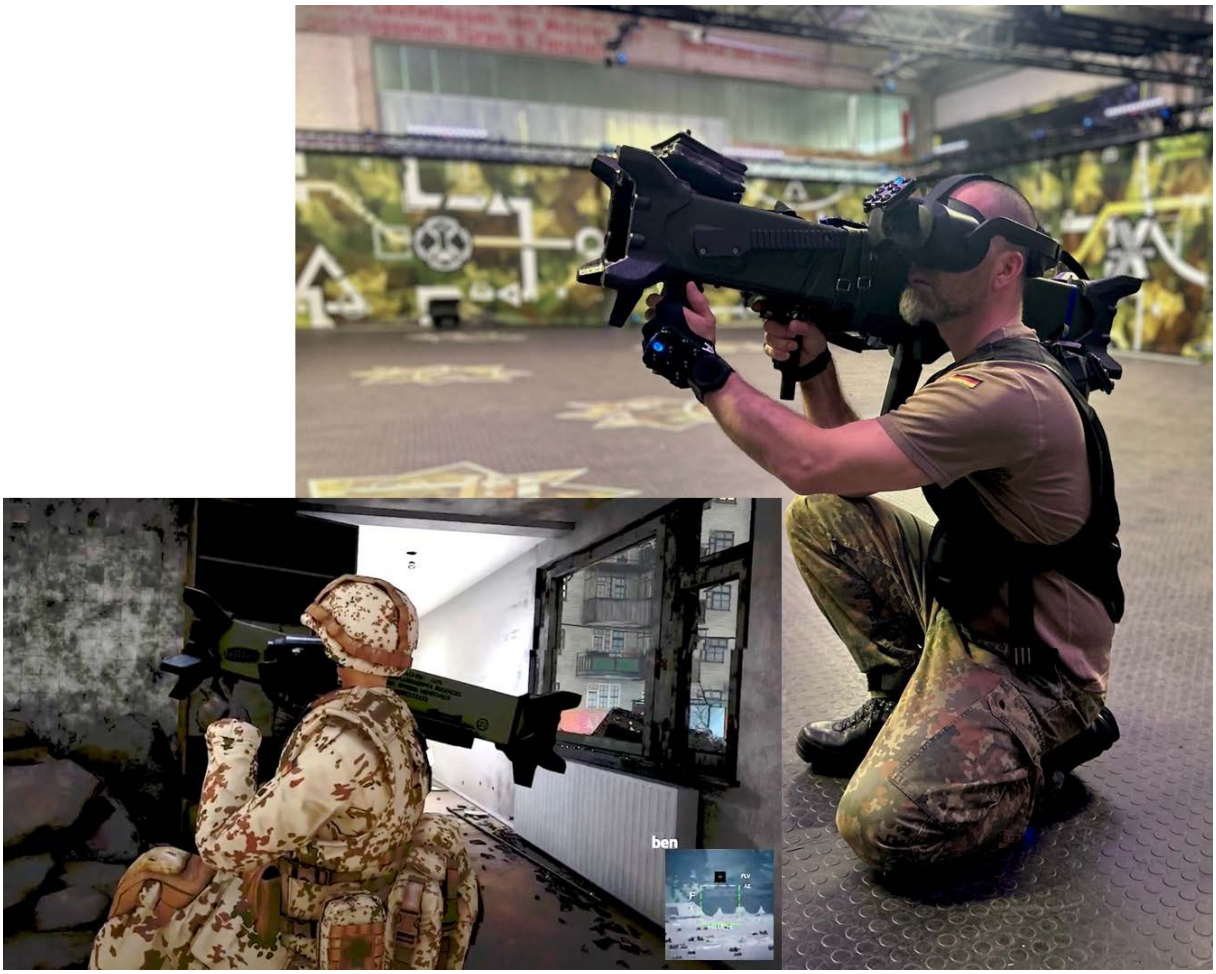

Figure 8: Light Weight Weapon system 1800+ with VR view (left) and real view (right)

- Reaction training with the weapon in VR
  Inspired by the classic shooting cinemas, the application "Reaction training with the weapon in VR" was implemented. In contrast to classic shooting ranges, which often work with fixed video films, the training sequences can be configured specifically and individually according to the training needs. The main difference to the shooting range is the possibility of using the virtual cover configured in the scenario and the possibility of reaction of computer-generated opponents. The application is completed with a comprehensive analysis of the shots fired, such as hit patterns, required reaction times, hit zones or self-scored hits by enemy computer-generated forces.

- Digital Map Table VR /Digital Situation Table VR
  The "Digital Situation Table VR" is an application from the Fraunhofer Institute IOSB. Among other things, this application enables site inspection in 3D. Movement within the 3D geodata is carried out using a controller. This application was integrated into the VR platform of the WTD 91. This adaptation now makes it possible to hold a situation briefing with four people in virtual reality on 200 square meters. To make it easier for users of the application to get started, a new interaction concept with "one-button operation" was also implemented.

OUTLOOK

This R&D study has impressively demonstrated the current possibilities and advantages of VR technologies. The technology has already reached a level that allows operational use. At the same time, however, the technology is developing at a rapid pace. The resolution and representation of the visualized content are becoming more and more realistic, and at the same time the technical effort required to record the movements of the training participants is constantly decreasing. In the future AI will take over the behavior of computer-generated forces. WTD 91 has set new study priorities with the development of a valid VR stress vaccination training and the use of AI for VR training. In this regard, training in virtual reality is continuously being developed further and will ultimately made available to the troops as powerful applications.

REFERENCES

1.
https://usabilitygeek.com/how-to-use-the-system-usability-scale-sus-to-evaluate-the-usability-of-your-website/

2.
Matthias Rauer: Quantitative Usablility-Analysen mit der System Usability Scale (SUS) (2011) In: Seibert Media Weblog.