D5.2

MR Trainings Environment, Trainings-Scenarios and MR Live Editor infrastructure for conducting the Evaluations

Version
V1.0

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Versions

Version	Date	Author(s)	Description
V0.1	26/06/2023	Helmut Schrom-Feiertag (AIT)	First draft and document structure
V0.2	06/07/2023	Matthias Dieterle (RFNS) Ronny Tobler (RFNS)	First descriptions on system setup and equipment.
V0.3	17/07/2023	Matthias Dieterle (RFNS)	Training content creation chapter added.
V0.4	27/07/2023	Matthias Dieterle (RFNS) Ronny Tobler (RFNS) Helmut Schrom-Feiertag (AIT)	Completion of the content with latest results and screens from the field trial.
V0.5	28/07/2023	Matthias Dieterle (RFNS) Helmut Schrom-Feiertag (AIT)	Final revision of the document
V1.0	31/07/2023	Matthias Dieterle (RFNS) Ronny Tobler (RFNS) Helmut Schrom-Feiertag (AIT)	Finalization of the document

Report Review

Version	Date	Reviewer(s)	Statement
V0.5	28/07/2023	Helmut Schrom-Feiertag (AIT) Vendula Rajdlova (AIT)	Report ok, minor formatting issues.

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List of Acronyms and Abbreviations

Acronym/ Abbreviation	
GUI	Graphical User Interface
MFR	Medical First Responder
MR	Mixed Reality
MREXCON	Mixed Reality Exercise-Control
MRSE	Mixed Reality Scenario-Editor
NPC	Non-Player Character
PC	Personal Computer
VR	Virtual Reality
WP	Work Package

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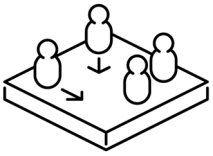
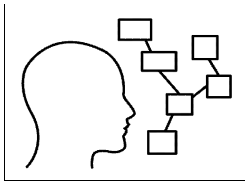
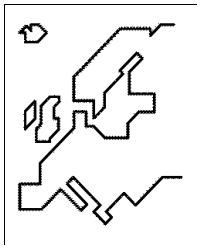
Relation to Objectives

Objective	Description
	**Obj. 1: Pioneering MR training approach for enhanced realism** The MR Trainings Environment contributes to the objective by building the basis for the execution of MR trainings. It will be tested in six field trials and further developed to the final system and its components. It consists of the MR scenario editor, exercise control, the integrated smart wearables, and the high-fidelity manikin to create the new extended MR training system to train emergencies with high-risk and demanding situations with high realism.
	**Obj. 2: Effective training scenarios and a training curriculum** With the developed scenario editor and the provided 3D assets for the virtual environment, the virtual patients with its wounds it is easy to create and adapt scenarios. Two scenarios were defined and will be evaluated about their effectiveness during the six field trials.
	**Obj. 3: Physiological signal and trainee behaviour feedback loop and smart scenario control** The integrated wearable devices for physiological data collection will be visualized in real-life for stress assessment during training and recorded and visualised for the debriefing and contributes to a comprehensive assessment of trainees' performance during training and for smart scenario control as well as deepening learning after training in the debriefing.
	**Obj. 4: Position the pioneering MR training approach across Europe** The MR training system will be demonstrated in six field trials across Europe and tested with over 200 trainees. The innovative system will demonstrate an enhanced training approach and is expected to generate interest among medical first responder organizations throughout Europe, fostering the exchange of knowledge between countries.

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Executive Summary

The main aim of MED1stMR is to better prepare MFRs for stressful and highly complex disasters situations by developing a new generation of mixed reality (MR) training with haptic feedback for enhanced realism. Through the integration of high-fidelity patient simulation manikins into the MR experience MED1stMR offers a much richer sensory experience. This MR training environment allows trainees to immerse into virtual scenarios and to feel and perceive actual movements of the limbs, head and face through tactile and visual interaction as they are actuated. Furthermore, it enables systematic manipulation of a large set of potential influence factors in order to optimize training effects. Training sessions can be recorded to deepen learning effects through reflection under and after-action with trainers.

To enhance the effectiveness of mixed reality training and consequently the performance of medical first responders (MFRs) in crisis situations a physiological signal and trainee behavior feedback loop is integrated allowing to monitor stress level of MFR during training for smart scenario control and recorded for later use during debriefing.

This deliverable describes the demonstrator of the MR training system with two collaboratively developed and implemented training scenarios to train emergencies with high-risk and demanding situations. The MR training environment represents a significant advancement in immersive training. By integrating virtual and real patient simulation manikins, it offers an engaging learning experience for learners. The scenarios provide realistic mass casualty incident simulations, enhancing critical skills and decision-making for emergency responders. MR interactions with non-player characters (NPCs) and the real manikin offer hands-on experience in a risk-free setting, elevating medical training. Positive feedback from the first field trial in Vienna emphasizes its potential to revolutionize training. Ongoing developments and biosignals data collection aim to enhance stress assessment and smart scenario control for personalized scenarios. We are committed to refining the system to provide effective and user-centric training solutions for medical first responders.

Relation to other deliverables and tasks in MED1stMR

Table 1: The work and the document build on results from the following deliverables.

No.	Title	Information on which to build
D2.2	End Users Perspective: Requirements Report, Stakeholder Map and Expectation Summary for Smart Wearables, MR Training Framework and Curriculum	The end user requirements are the foundation for all developments of the MR training environment including the manikin features and the wearables for biosignals measurements.
D2.3	Guidelines and Inputs for the future Training Scenarios	The developed guidelines were used for the collaborative creation of the two training scenarios.
D2.4	High-Level System Architecture	The high-level system architecture serves as the fundamental blueprint for the technical structure of both hardware and software components. It lays the

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		foundation for a well-integrated and robust system that facilitates seamless interactions and optimal performance.
D4.1	MR Technology Framework for Responsive Human-Manikin	By establishing a clear and well-defined technology framework, the document outlines the essential components, functionalities, and requirements for the responsive manikin's design and implementation. It serves as a reference point for developers, engineers, and designers, ensuring a unified understanding of the desired outcomes and capabilities of the manikin.
D4.3	Activity Recording for the Exercise Debriefing	The document guides our MR system debriefing development. Real-time tracking captures trainees' interactions with virtual scenarios and manikins, enhancing personalized debriefing and skill improvement in medical training.
D4.4	Physiological signals Acquisition Hardware and Software Framework	D4.4 describes wearables hardware, data acquisition software, and proper usage. It outlines wearable selection, data processing, and analysis for accurate physiological data during training. Guidelines ensure effective usage, enhancing training outcomes.
D5.1	VR System Design Document and Evaluation Plan for MED1stVR MR Trainings Environment	D5.1 outlines the MR system design and evaluation plan for the mixed reality training environment. It provides details on the architecture and components of the MR system, ensuring seamless integration.

Table 2: The results of this work will be incorporated into following work and developments

No.	Title	Basis for
D6.2	Field Trial and Studies Combined Analysis Report	The described MR Trainings environment builds the technological basis for the field trials and the studies and provides the description of the system used.
D6.5	MED1stMR Final Evaluated VR Training Scenarios	The scenarios are created with the scenario editor and screens are shown in this deliverable and provide the foundation for the final evaluation of the training scenarios.
D6.6	MED1stMR Final Guidelines for VR Training	This document will inform the D6.6 Final Guidelines for VR Training. It assesses MR system advancements, user experiences, and training practices, identifying strengths and areas for improvement.

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1 Introduction

This deliverable builds on D5.1, that describes the MR system design and defines the evaluation plan for the mixed reality training environment. The design is based on the end user requirements and guidelines and inputs for future trainings scenarios gathered in D2.2 and D2.3. In the MR training the user will be immersed into these training scenarios using the existing MR environment developed by RFNS for use in training medical first responders in several fields of disasters. Furthermore, a MR Scenario-Editor (MRSE) and MR Exercise-Control (MREXCON) was be developed and integrated into the MR system. With the MRSE the researchers or trainers can define and manipulate the context (e.g. use of stress cues), situation and settings of the scenarios before training. With the MREXCON, researchers and trainers start/stop and modify scenarios during training allowing maximum freedom to adopt to the objectives of field trials.

2 System Setup

2.1 Overview

The MR training environment is a cutting-edge platform designed to provide an immersive and interactive learning experience. It combines virtual elements with the real-world elements, real patient simulation manikin, to create a seamless and lifelike training environment. The following Figure 1 shows an overview of the essential components and setup of a mixed reality training system.

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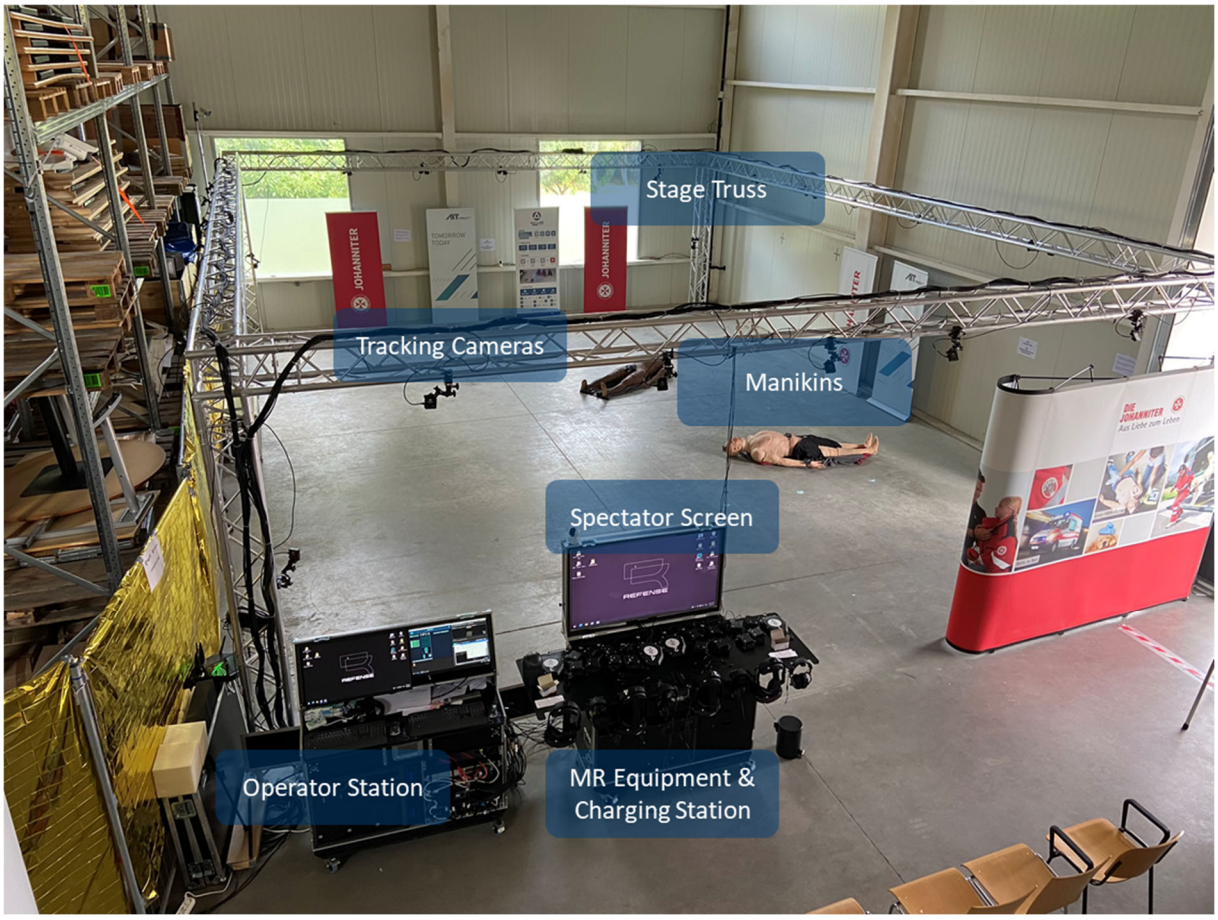

Figure 1: MR training environment showing trainer station, spectator station and stage truss setup.

Tracking cameras are securely mounted on the truss surrounding the training field and connected to the main computer for stable and optimal coverage. The setup's efficiency and ease of use make the field trial experience seamless and immersive. The thoughtful organization and accessible design facilitate smooth operation for both operators and the audience, contributing to a successful and engaging field trial.

The field trial setup is designed to be user-friendly, featuring two flight cases equipped with high-performance computers. Assembly is straightforward, requiring only a minimal number of cables for connections. The virtual scenario can be observed effortlessly by both the operator and spectators through designated links: The operator's station on the left and the spectator's screen on the right (Figure 2).

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Figure 2: Operator station and spectator screen of the MR setup.

The single components with operator station, spectator screen, and MR equipment are described in the following sections.

2.2 Operator Station

The MR operator station for training execution is a powerful control center that enables trainers to manage and control immersive MR training scenarios. It features a high-performance computer system, a specialized MR headset, and intuitive controls. Trainers can manipulate virtual environments, provide real-time guidance to trainees, and monitor their progress from different views (top view, perspective from a trainee, or free camera position). With hands-on interactions and seamless collaboration, the MR operator station empowers trainers to create dynamic and effective training experiences, enhancing skill development in a safe and engaging mixed reality setting.

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Figure 3: Operator Station

2.3 Spectator Station

The MR spectator station offers an engaging view of immersive training scenarios. Visitors can observe trainees' activities through large displays and witness the seamless integration of virtual elements with the real-world environment. The station provides an informative and captivating experience for spectators, showcasing the dynamic training content and the participants' interactions within the MR environment. It allows visitors to gain insights into the training process, perceive trainees' skill development, and appreciate the benefits of MR training in a concise and visually compelling manner.

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Figure 4: Spectator Screen with the view from the perspective of a trainee.

2.4 MR Equipment

The MR equipment combines a cutting-edge full body tracking system and a state-of-the-art wireless headset to create an unparalleled training experience. With our full body tracking system, every move you make is accurately reflected in the virtual environment, allowing for natural and realistic interactions with the training scenarios. Whether practicing complex maneuvers or refining essential skills, the full body tracking ensures that your actions seamlessly translate into the virtual world.

The wireless headset adds another dimension of freedom to the training without limitations of cords and cables or wearing a PC on the back, allowing to move effortlessly and explore the virtual space without any hindrance. The wireless design provides a truly immersive experience, untethered from the physical world, and fully engaged in the training environment. The MR equipment opens up a realm of possibilities, where trainees can practice, learn, and grow in a safe and dynamic setting.

For added convenience, the MR equipment can be easily attached to marked stations for charging purposes (Figure 5).

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Figure 5: Charging station for the MR-equipment

2.4.1 VR- Equipment overview

This section provides step-by-step instructions for turning on the VR equipment, cleaning it after each training session, and equipping participants with the VR equipment. Participants have their own VR sets, which ensure smooth training

Each participant has the same equipment, which includes: Two hand sensors, two foot sensors, one back sensor, and a VR headset with headphones. The individual components are depicted below.

Hand & Foot Sensor Back Sensor VR Headset, Headphones& Radio

Figure 6: MR equipment for a trainee.

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Figure 7: Fully equipped participant in action.

2.4.2 Instructions MR equipment

In the following instruction for the MR equipment how to power on, clean the equipment, equip the trainee and disassembling is described.

2.4.2.1 Step 1: Power on the MR equipment

The steps for power on the MR equipment are shown in the following Figure 8. To start the MR headset HTC Vive Focus 3, press and hold the power button on the battery for approximately 5 seconds until the LEDs begin to illuminate.

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Figure 8: Powering on the MR equipment

2.4.2.2 Step 2: Clean VR equipment

The VR headset and headphones need to be cleaned after each training session. In particular, the lenses of the VR headset must always be kept clean to ensure a clear view into the virtual world. When cleaning, it is important to use only the microfiber cloth specifically designed for cleaning the VR lens, without any liquid, as using liquid can permanently damage the lens. Disinfection wipes are used for

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cleaning the VR headset faceplate and the headphones. The illustrations below indicate in green what can be cleaned with each respective cleaning cloth.

Cleaning of lenses (microfiber)

Microfiber

Cleaning of HMD faceplate (Disinfection wipe)

Disinfection wipe

2.4.2.3 Step 3: Equip with VR equipment

Before wearing the VR equipment, ensure that the sensors and VR headsets are powered on and clean.

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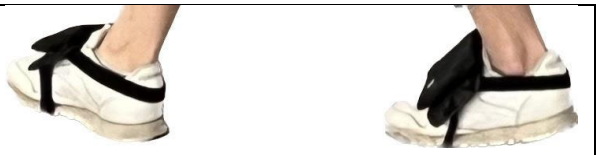
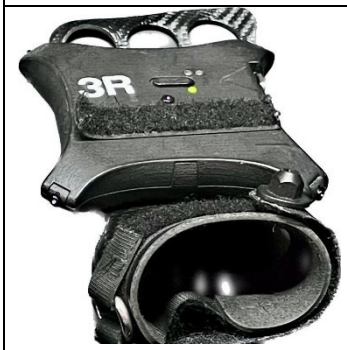
Each participant has their own VR set, which can be identified by the number displayed on the VR equipment (e.g., VR Set 1: the foot, hand, and back sensors, as well as the VR goggles, will have the number 1 on them). Additionally, the hand and foot sensors will have the letters "R" for right and "L" for left. When equipping, it is important to note that the numbers on the sets should match, and the right sensors should be placed on the right side.

- Start by putting on the foot sensors, ensuring that they are oriented correctly (the numbers and letters are readable for the participant) and placed on the appropriate side. The foot sensor has two rubber bands, with the rear one being placed over the heel and the front one secured below the foot.
- Next, put on the hand sensors in the correct orientation and on the correct side. The hand sensors rest on the back of the hand, with the participant first sliding their hand through the wrist strap and then fastening the elastic band in the center of the hand near the little finger. Finally, the little finger, ring finger, and middle finger go into the designated openings on the hand sensor.
- Place the back sensor on the back and fasten the attached elastic band with the corresponding click closure around the abdomen.
- Finally, put on the VR goggles with the headphones. The size of the VR goggles can be adjusted using a wheel at the back of the head for a tighter or looser fit. The participant should tilt the goggles slightly up and down until the image seen through the VR goggles becomes clear.

The illustrations below provide a visual representation of the equipment setup for better understanding.



Tightened foot sensors with visible positioning of the rubber bands



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Hand sensor with wrist strap and designated finger openings	Hand sensor with wrist strap and designated finger openings Left hand sensor tightened
	
Tightened back sensor	Tightened headset and headphones

Figure 9: Visual illustrations of the equipment setup for better understanding.

2.4.2.4 Step 4: Disassembling and charging the VR equipment

After the training session, the VR equipment is set aside, cleaned (Step 2), and placed on charge. It is important to note that the VR headset should be laid down on the table with a slight tilt to ensure the cable attached at the bottom remains undamaged. The hand, foot, and back sensors are charged in the same manner by connecting them to their respective magnetic charging cables. As depicted below, the VR headset is charged using the charging port located at the back of the headpiece. Regular charging of the VR headset is recommended, as it has a maximum battery life of 2 hours per charge.

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- Only charge the trueVR Active Puck Tracker with a micro USB cable from a USB power source (5V DC).
- Approximately 2 hours for a full charge

Power – (Top-Left)	Illuminates in green and blinks every 5 seconds	Battery sufficient
Power	Yellow/orange	Approximately 1 hour left
Power	Red	Approximately 20 minutes left until power is depleted
Charging – (Top-Right)	Green	Fully Charged
Charging	Red	Charging / Idle
Charging	Yellow/orange	Bad battery. Stop using the puck and contact support

Figure 10: Charging of the equipment.

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2.5 Scenario Execution

To initiate a scenario, the VR equipment is first explained to the trainees and set up. The operator GUI (Graphical User Interface) is then launched with the selected players, and the training session begins. If a red "Bible"-icon or a red warning field appears to the right of the player, it indicates that the respective VR headset have not been turned on (Figure 11).

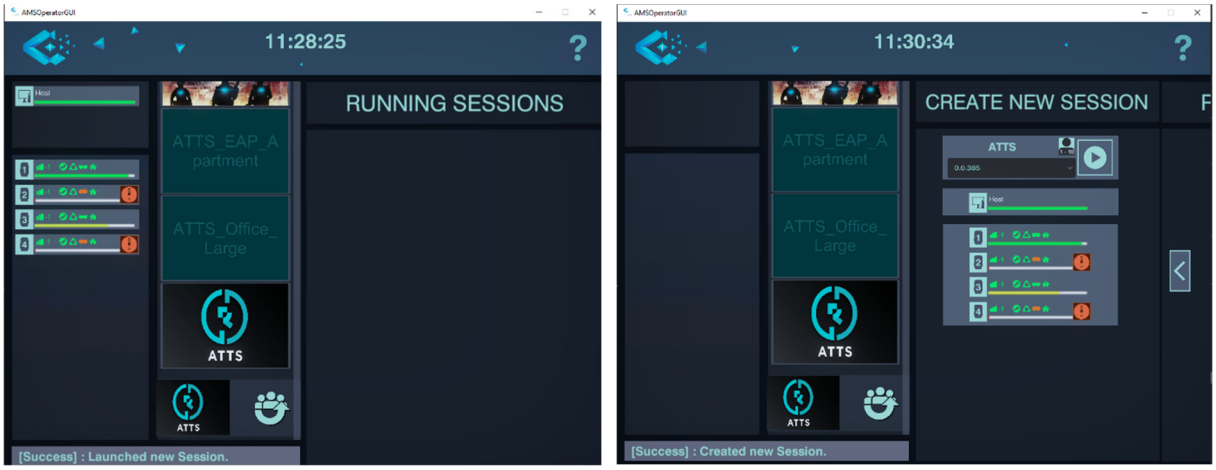

Figure 11: Operator GUI indicating that VR headset 2 and 4 is not turned on.

The GUI is designed to be intuitive, allowing the operator to quickly identify and address any issues that may arise. During the training session, participants are granted the freedom to explore the virtual environment, choose their preferred characters, and perform calibrations if necessary. The session involves interacting with two mannequins, providing valuable opportunities to practice triage card assignments. While one of the mannequins can be moved around, the other remains fixed at a specific location marked by a ground marker. Before proceeding, participants should wait for the PLUX wearable connection to be established, which is indicated by a double blink. It's essential to note that the clients connect to the devices in a staggered manner: Client 1 connects after 15 seconds, followed by Client 2 after 15 seconds, Client 3 after 15 seconds, and Client 4 after 15 seconds. Once the PLUX wearables are successfully connected, the session commences with a baseline heart rate test. Participants are required to focus on the plus sign for two minutes without making any movements. Detailed description for the PLUX wearables can be found in D5.4.

In the virtual lobby (Figure 12), all necessary preparations are completed, and stress visualizations will no longer appear gray, signaling that the scenario is ready to begin. Participants then gather at the designated start area to commence the scenario. The stress visualizations are continually updated with PLUX data and will no longer appear gray once the data is received. In the event that PLUX is not connected, the stress visualizations will remain gray. During the scenario, participants can carry out triage tasks using the triage cards and tourniquets located on their left and right arms. Additionally, the operator has the ability to relocate all green NPCs (mannequins) to the safety zone using a designated button. However, it is important to keep in mind that the manikins are not aware of any obstacles and will simply walk-through other NPCs or players in their path. Upon completion of the

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scenario, it is crucial to click the "stop data gathering" button, as this is vital for the purpose of replay and data collection. Following a brief waiting period to ensure that all files are transferred, the game can be concluded. As for debriefing, the session should be initiated with debriefing, and participants should click the Load button to select the replay from the designated folder. Once the replay is complete, participants can press "exit" to conclude the after action review session.

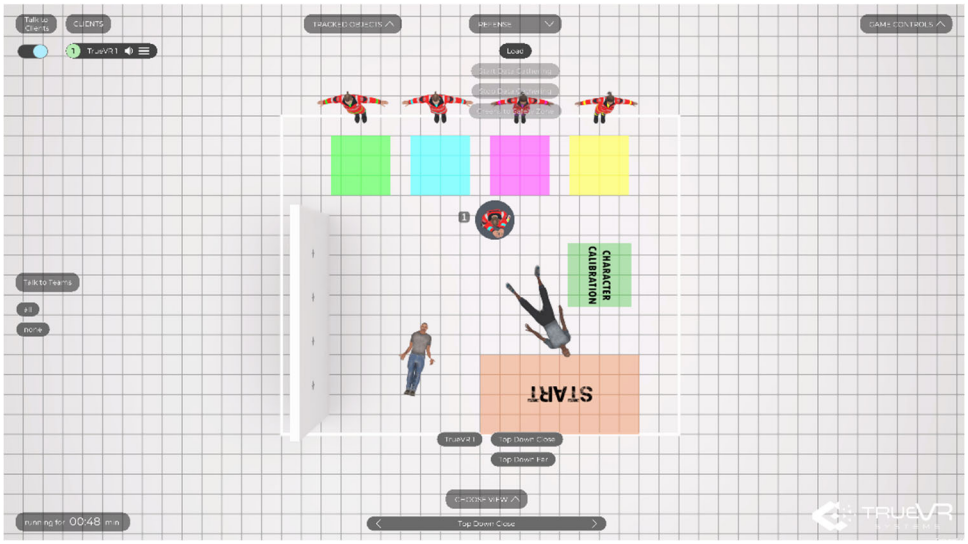

Figure 12: Virtual lobby for introduction, calibration and baseline measurement.

2.6 Trainee Interactions

MR interactions transform medical training, enabling trainees to practice vital life-saving techniques in a dynamic and immersive environment. In the scenarios, trainees can seamlessly check a patient's pulse and breathing rate virtually from NPCs and physically from the manikin, assess strong bleeding, and apply triage cards and tourniquets virtually.

2.6.1 Checking pulse

Trainees can use their hand tracking to approach the virtual patient and place their fingers on designated pulse points, such as the wrist or neck. Then a window with the pulse is shown to the trainee.

Figure 13: Checking pulse of a victim

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2.6.2 Checking respiration

For checking respiration, trainees can observe the patient's chest rise and fall animation to determine the breathing rate, check the mouth and listen to breathing sounds, within the virtual environment.

2.6.3 Physical manikin interactions

On the physical manikin trainees will feel haptic feedback, simulating the sensation of a real pulse on the wrist and neck. Simultaneously, they can feel the patient's chest rise and fall to determine the breathing rate, all within the virtual environment.

2.6.4 Triage card

Trainees are provided with virtual triage cards and can select and apply them to the patients according to their condition and severity. This interactive process helps them prioritize treatment and allocate resources effectively. The following Figure 14 describes the interaction steps.

Figure 14: Virtual interactions to apply a triage card.

2.6.5 Tourniquet:

Trainees also equipped with a virtual tourniquet to practice applying tourniquets accurately. The interaction steps are described in Figure 15.

Figure 15: Virtual interactions to apply a tourniquet.

3 Training Content Creation

The creation of training content for the MR training involves close collaboration between medical experts, trainers, designers, developers, and content creators. This synergy ensures that the content is accurate, relevant, and aligned with the desired learning outcomes. The success of any training system depends on user adoption. A user-friendly scenario editor for creating training content encourages more users to adopt the technology, leading to a broader and more successful implementation within an organization or first responder domain. Therefore, the scenario editor of

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MED1stMR is an easy-to-use application like a house builder with drag and drop functionality. The application is commanded by keyboard and mouse den described in the following.

3.1 Scenario Editor

The following text provides a brief description of the scenario editor. With this tool, you can create a virtual world specifically designed for training purposes. The process of creation is straightforward: Simply select the desired type of element from the menu and drag and drop it onto the virtual terrain. Elements like can then be adjusted in length according to your preferences, forming the building's layout. Once the layout is complete, you can place objects by dragging and dropping them onto the virtual terrain and using arrows to position them accurately (Figure 18). Circular spheres allow you to adjust the objects' orientation to your needs (Figure 19). A wide range of objects is available to create an incident site. Additionally, various types of NPCs, such as perpetrators or injured individuals can be placed on the ground.

Two perspectives are available to edit the virtual world from different viewpoints: the "Top-View" (Figure 16) provides an elevated position to observe the entire world, and a freely movable camera allows you to explore the virtual environment from different angles. Once the virtual world is created, you can save it at any time and revisit it for further editing or utilize it for training purposes once it is finalized.

Figure 16: Scenario editor with top-view, white rectangle around victims indicates walkable area in the MR system.

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Figure 17: Scenario editor with view free camera view.

Figure 18: Positioning virtual object by handles for x-, y- and z-axis.

Figure 19: Adjustment of the alignment virtual object with handles for rotation.

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The scenario editor is built in a way that the logic or intelligence is on the object that we integrate. That can be a vehicle such as a bus or a car or building objects such as doors and windows or an NPC. On these objects we can integrate injuries that have to be assessed and/or treated according to specifications of the end users to succeed or fail in the training.

The easy-to-use scenario editor is vital for the MED1stMR training system. It allows customization of content, rapid development, and adaptability for non-technical users. The reduced learning curve saves time for trainers, while iterative improvements enhance user experiences. Multimedia integration enriches learning. The editor also leads to cost savings in training development. Overall, its role in customization, efficiency, and user-friendliness ensures widespread adoption, contributing to successful training outcomes and organizational success.

3.2 Training Scenarios

Two MR scenarios that have been developed based on the requirements D2.2 and guidelines and inputs for trainings scenarios D2.3. The two scenarios have the same training goals and learning objectives.

Overarching training goals

- ✓ To be better prepared to handle (first) triage at the scene of a mass casualty incident
- ✓ To contribute to the development of the technical system and the overall training design

Learning objectives

Based on what emerged from the needs analysis conducted in WP2 regarding the needs and requirements of end-user organizations for MCI training and the possibilities and limitations of the Med1stMR training system, the following learning objectives have been created:

After the training, the trainees are able to ...

1. Organize and coordinate the work at the scene of the mass casualty incident
2. Perform a timely and correct triage (based on algorithm used) of MR patient (manikin) and proper use of triage card/color
3. Identify the patient's vital parameters and decide on and demonstrate the correct actions and prioritizations based on triage algorithm used
4. Use purposeful communication with triage commander, team members, and injured people
5. Perform a continuous risk assessment

Trainees will be tasked with assessing the scene, triaging victims based on their injuries (consciousness, pulse, breath rate, strong bleeding), and providing appropriate medical attention. They will also need to coordinate within the team and demonstrate effective communication and teamwork skills to manage the situation successfully. Once they have triaged all, one person will give a handover to the triage commander (played verbally by the trainer), with the following information:

1. How many injured people in total?
2. How many people of which category?

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3. What rescue resources do you still need now to adequately care for all patients?
4. How would you proceed further?

After the communication of this information the training ends. In the following the two scenarios, a bus crash on a country road and in a tunnel are described.

3.2.1 Scenario 1 – Country Road Bus Crash

The first scenario is a bus crash MCI which was chosen as it was frequently mentioned as relevant by end users (see D2.2) and in the literature. Furthermore, it allows all relevant learning objectives to be trained and focuses mainly on MFRs. In this training scenario, trainees will face a simulated bus crash incident with approximately 20 victims. The location is a country road, and the scenario takes place on the day and time of the actual trial, adding an element of realism. The weather conditions on the scene are cloudy, with no rain. To enhance the immersion, sound effects of environmental noises recreate the atmosphere of an actual accident site. The scenario includes a life-size virtual bus and the rescue services have already assessed the intervention zone as safe, and traffic on the road has come to a complete stop to ensure the safety of the trainees and the overall experience.

Figure 20: Scenario 1 – country road bus crash (top view in the exercise control).

The scenario is designed to challenge trainees to make critical decisions under pressure, assess risks, and prioritize their actions to save lives efficiently.

3.2.2 Scenario 2 – Tunnel Accident

In this training scenario, trainees will be immersed in a simulated bus crash incident that occurred in a tunnel (Figure 21). The visuals and sound effects accurately depict the accident site, including environmental sounds that create a sense of urgency and characteristic of a tunnel setting. Trainees will face the complexities of rescuing victims and managing resources effectively within the confined space of the tunnel. It is worth mentioning that a tunnel scenario also demonstrates very well how easy it is to train in environments that are otherwise difficult to make available for training, as they would have to be closed off separately.

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Figure 21: Scenario 2 – bus crash in a tunnel (top view).

4 Debriefing

Introducing our Debriefing System – an innovative and user-friendly tool designed to enhance your simulation experience by capturing every crucial moment in detail. With a simple initiation process, just load the replay file using the "load" button, and you'll be ready to immerse yourself in a comprehensive analysis.

The interactive interface allows you to engage with patients and closely monitor vital signs, including heart rate, breathing frequency, and expected triage outcomes. The state-of-the-art "Bender" camera smoothly glides through the simulated environment, offering multiple perspectives for a more profound review.

Navigating the system is done with intuitive keyboard and mouse controls. Zoom in effortlessly using the "w" key, zoom out with "s," and fluidly move left and right with the "a" and "d" keys. Furthermore, adjusting the camera angle is as easy as holding the right mouse button. Though sound recording isn't available at present, our dedicated team is actively working on integrating this feature to further heighten the immersion and create a more realistic experience. At its core, our Debriefing System aims to deliver valuable insights, foster professional growth, and empower you to effectively refine your skills. Embrace the endless possibilities it offers and maximize your simulation training with ease.

The current debriefing system is a first version and will be further developed and the final state will be documented in *D5.6 – MR Debriefing System for Training Performance Evaluation and Output for Evaluation and Field Trials*.

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Figure 22: Different views with the debriefing system.

5 Summary and Outlook

The development of the Mixed Reality Training Environment represents a significant step forward in the realm of immersive and impactful training methods. By seamlessly integrating virtual and real patient simulation manikins, our system offers a unique and engaging learning experience, empowering learners to acquire new skills and knowledge effectively.

The training scenarios provide an immersive and effective learning experience for emergency responders. By exposing trainees to a lifelike incident with multiple victims, realistic environmental factors, and potential risks, they can develop critical skills, improve decision-making abilities, and enhance coordination and communication in a high-pressure emergency setting. Through the developed MR interactions with NPCs and the real manikin, trainees gain invaluable hands-on experience in a risk-free setting. The interactive nature of the training enhances critical thinking, decision-making, and motor skills, preparing medical professionals to respond effectively and confidently in real-life emergencies. This immersive and engaging experience elevates medical training to new heights, ensuring better patient outcomes and improved emergency response in mass casualty incidents.

The first demonstration of our MR training system marks a significant advancement in the field of immersive learning. Following the first field trial in Vienna from 24th to 28th July 2023, we are pleased to report overall positive feedback from participants, confirming the system's potential to revolutionize training experiences. The preliminary feedback highlighted areas for improvement on the technological and operational fronts. However, the system's ease of setup and operation was particularly praised, allowing local trainers to take charge after just a half-day train-the-trainer session.

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To further enhance the system's capabilities, ongoing developments are underway, guided by continuous evaluation and user insights through further five field trials in the next half year. Additionally, we are collecting biosignals data to build reliable stress assessment models and enable smart scenario control for personalized training scenarios.

With a commitment to innovation and optimization, we are dedicated to refining the MR training environment to offer unparalleled training experiences for medical first responders. We eagerly anticipate the continued development of our system as we work towards providing the most effective, engaging, and user-centric training solutions.

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