VR4 Skills

Guidelines on how to build VR learning environment

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Best practices for creating scenarios for solutions using virtual reality with immersion level 1 (360-degree photos) and 2 (360-degree videos)

Introduction

When creating VR educational scenarios, it should be remembered that the overriding goal is to prepare the trainee to solve a specific problem by making the transfer of knowledge and instructions for performing activities/skills as attractive as possible. It should also be borne in mind that VR is a so-called interactive theory, which does not replace practice, but allows the trainee to experience various paths of approach to the problem at almost no cost. Importantly, in the group of possible alternatives we find both correct solutions, partially correct solutions, as well as wrong solutions in various ways. The effectiveness of conducting training with the use of a VR simulator depends on designing a virtual world as close as possible to the correct solutions, as well as the mistakes that trainees would make if they took part in training in reality. Each alternative path for the implementation of the scenario, translates into a certain number of scenes, the need to involve actors, props, scenery, editing, sound design, etc. and therefore directly translates into the cost and time of implementation of the simulator. Therefore, it is very important at the outset to precisely define the purpose of the VR simulator, and all other components of the simulator should be tailored to the goals you plan to achieve. It is worth noting that the results of the research of threat researchers indicate that educational games are seemingly considered ineffective, however, this is not true. Their low effectiveness is due to the routine way in which they are created - educational games usually present only the right path to solve a problem and little challenging alternatives that do not challenge trainees. Moreover, most often these games lack a plot/narrative, and thus the only emotions they cause are possible frustration in case of failure, lack of interest in independent attempts by the trainees, and a sense of compulsion of having to get a result. Therefore, contemporary research work in this area strongly emphasizes the need to consider during the creation of a scenario not only how to implement it, but also how to make it attractive so that it is possible to "play" it repeatedly, which directly implies the need to implement a solution with a non-linear path of success and/or in different variants of difficulty levels. Let's also remember that working on VR scenarios is an iterative solution, which can usually be considered successful after 2-3 iterations. An exclusively single iteration usually does not exhaust the relevant erroneous paths to be considered, and is most often devoid of "enhancements" that affect the emotions of the trainee. When defining scenarios, those that happen in rooms with artificial lighting are preferred. This allows unlimited recording time. The use of "daylight" unfortunately enforces very specific restrictions on the recording time, otherwise the trainee will very easily distinguish that, for example, all the negative variants of the scenario are darker,

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because they were recorded later in the recording day. It should be avoided at all costs to allow trainees to make such an off-the-charts distinction between scenario variants. See examples in attachment no. 1.

Steps to define a VR scenario:

1. Selection of available VR equipment and controllers and how to interact.

Typical modes of interaction available for VR immersion levels 1 and 2 are:

- Turning the head in a way that centers the element of interest and holding that position for at least 5s. Performing such actions is typically interpreted as a willingness to interact with an active element visible at that location (a character, a prop, a clue that you can go to that place - analogous to arrows in Google Street View, for example).
- Pointing to a given active element with a beam starting at the VR controller (the trainee's hand) and pressing a button on the controller (typically the largest button on the controller, known as the trigger).
- Time lapse. For example, if 30s pass and the trainee does not take any action it automatically goes to the scene defined in the time criterion. Usually, these scenes cause escalation of the main problem.

2. Determine the main objective and sub-objectives of the educational scenario.

Example:

- Main goal: To understand safety rules during a fire.
- Sub-objectives: To learn how to use a fire extinguisher, how to leave the building properly during a fire, how to use a fire mask.

The main objective and sub-objectives most often come from existing training materials used in classical training. However, it is worth thinking them over carefully before starting to prepare a VR scenario, because in VR we can most often reproduce many different variants that in reality would be difficult, impossible or very expensive for all trainees to implement. Therefore, usually the specific objectives of VR scenarios are more numerous and more specific.

3. Determining the name of the scenario.

Example: "Fire: Evacuation and Safety Simulator."

4. Identify model ways to implement which we want to teach.

Example: In the scenario, we want participants to learn how to use a fire extinguisher by pointing it at a fire source and squeezing the trigger.

The model way of solving a problem in a scenario is usually defined in classic training materials or are created on the basis of consultations with experienced practitioners and domain experts. Often, it happens that the correct solution of a problem depends on the

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context, external factors, location, or time of day or weather. Therefore, all these issues are important to identify when defining the location and conditions of the scenario in the following sections.

5. Identification of the most common mistakes made during actual problem solving.

Example: incorrect selection of an extinguishing agent for the situation.

6. Identification of the most common mistakes made by participants in traditional training.

Example: Not understanding the difference between different types of fire extinguishers. Premature use of a fire extinguisher.

7. Assuming the most common mistakes made by VR trainees.

Example: Low situational awareness as a result of looking ahead instead of looking around to search for threats, resulting in overlooking threats "behind the back." In this section, consider the behavior of VR trainees directly while using the simulator. Trainees may confuse buttons, trip over something, have difficulty aiming at small items, become fatigued over time of use, etc.

8. Determine the location of the scenario.

Example: an office building with three floors with different types of rooms: conference rooms, kitchens, offices. It is important to specify spaces that are realistic and with consideration of the possibilities and budget for later recording.

9. Identify the props needed for the scenario.

Example: Fire extinguishers, fire doors, escape stairs, items for controlled burning. It is important to specify items that are realistic and with consideration of the possibilities and budget for later recordings.

10. Identify optional props for the scenario.

Example: fire masks, evacuation plans, first aid kits. It is important to identify sites that are realistic and with consideration of the possibilities and budget for subsequent recording.

11. Identify the characters necessary for the scenario.

Example: Firefighters, building employees, possibly fire victims.

Each character should be described at a sufficient level of generality to be clearly distinguishable by the trainees, while leaving some leeway for the team during the implementation of the recordings. Typically, gender, estimated age, stature, distinctive clothing (if present, such as firefighters) are specified. Optionally character, attitude during the scenario playback, e.g. aggressive and disruptive to the trainee, neutral, helpful, etc.

12. Identify optional characters for the scenario.

Example: Security personnel, managers, visitors to the building.

Each character should be described at a sufficient level of generality to be clearly distinguishable by the trainees, while leaving some leeway for the team during the implementation of the recordings. Typically, gender, estimated age, stature, distinctive clothing (if present, such as firefighters) are specified. Optionally character, attitude during the scenario playback, e.g. aggressive and disruptive to the trainee, neutral, helpful, etc.

13. Determination of difficulty levels (typically: easy, difficult(actual) or easy, medium

Example: Easy level (all exits are accessible, little smoke), difficult level (some exits are blocked, lots of smoke).

It is worth remembering that each successive level of difficulty is the performance of an additional whole scenario, however, usually very similar, therefore possible to record with the same actors, props and location in the same recording window.

14. Determination of evaluation criteria per established levels of difficulty.

Example: Did the participant use the fire extinguisher correctly? Did he find a safe escape route? Did he make decisions in less than 30s?

Typically, the criterion for evaluation is the correctness of the choices made and/or fitting in the execution of the scenario within a certain specified time.

15. Define the scene graph considering points 4,5,6,7.

Example: Flow diagram with different paths, depending on the participant's decision - using a fire extinguisher, escaping by stairs or elevator, providing first aid to others.

- The nodes of the graph represent each scene of the scenario.
- The edges of the graph represent the relationships between the different scenes of the scenario. Relationships in a graph are unidirectional, however, they can be looped. If we design looped graphs it is necessary for the designer to take into account an exit criterion, such as time to avoid infinite execution of the scenario.

Any graph drawing tool can be used to draw a graph. Below are some of the most popular ones:

- https://www.diagrams.net/ - free
- https://coggle.it/ - partly free
- PowerPoint or another tool from the office suites for creating presentations
- https://dreampuf.github.io/GraphvizOnline/ - free

16. Identify triggers for transitions between scenes.

Example: Using a fire extinguisher can move the participant to the next scene, where he or she must check that the fire has been completely extinguished.

In this step, we determine for each scene what triggers are available for transitions between scenes. Typically, such triggers would be the participant interacting (as

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defined in step 1) with, for example, an arrow on the screen - which switches to the next scene "in a given direction", and thus allows the participant to move around the virtual object. It can also be interacting with a displayed dialog box (selecting a line of dialogue with a character), a specific object or character (it is customary to accentuate "active" elements in the scene so that the user does not experience the frustration of trying to touch everything one by one and see what options are available to him).

17. Determination of scores for each evaluation criterion per significant transitions between scenes.

Example: Using a fire extinguisher correctly - 10 points; finding an escape route - 5 points; providing first aid - 15 points. Transitions between neutral scenes, such as a virtual walk through a building, etc. typically have a score of 0, that is, they are neutral for the final score.

18. Define the description of each scene with the triggers available for that scene to move to the next scene.

Example: Scene 1: The beginning of a fire in the kitchen. The player sees fire and smoke. He must decide whether to use a fire extinguisher or run away.

For each scene, you need to specify what should be recorded by the scenario implementation team. Therefore, per each scene should be specified:

- Location,
- Weather conditions (if applicable),
- Time of day (if applicable),
- Props,
- Characters,
- Elements that trigger scene transitions,
- Sound (typically it's silence, but there can be ambient noise, or specific characteristic sounds of a place, such as seagulls singing in the harbor).

19. Determination of screens (scenes) of scenario interruption due to a critical error of a trainee.

Example: If a player fails to respond to a fire within the first 30 seconds, the screen turns red and a failure message appears.

20. Determination of the result screen.

Example: The screen shows the number of points earned, the number of successful and unsuccessful activities, and an overall evaluation of the participant's conduct. During this stage of scenario development, you should consider what data should be collected for the evaluation of the trainee and in what form. For example, should the entire transition be recorded from the trainee's point of view and saved as a video for later viewing/evaluation/presentation, or should only point scores and the start and end date of the scenario be recorded.

Best Practices for Creating VR Static 3D Scenarios

Introduction

When designing VR static 3D scenarios, it is essential to align the objectives of the simulation with the educational or experiential goals of the project. Static 3D scenarios offer immersive environments using captured 3D imagery or pre-rendered models, making them suitable for training, education, and visualization. These scenarios emphasize contextually accurate environments and guided interactions, ensuring effective user engagement and knowledge transfer.

Key Principles

1. Define Objectives Clearly:
    - Identify the primary objective and sub-objectives of the scenario.
    - Tailor content to align with training goals, such as skill acquisition, safety awareness, or problem-solving.

To effectively create a VR scenario, it is crucial to define the objectives with precision. Begin by identifying the primary objective of the scenario, which represents the main goal that the experience aims to achieve. This could include skill acquisition, such as learning a technical process or mastering a specific tool; safety awareness, such as understanding emergency evacuation protocols or identifying hazardous conditions; or problem-solving, like improving critical thinking or decision-making in complex environments. Alongside the primary objective, outline sub-objectives that break down the larger goal into manageable, specific outcomes. These sub-objectives should reflect the incremental steps necessary to reach the overarching aim and ensure the scenario aligns closely with the intended training goals. For instance, if the primary goal is to enhance safety awareness, sub-objectives might include identifying safety hazards, understanding protective equipment usage, and practicing response protocols in simulated emergency situations. By carefully tailoring the content of the scenario to match these objectives, developers can ensure that the VR experience effectively supports the desired educational or training outcomes, offering users a targeted and impactful learning experience. Defining objectives is not merely about setting broad goals but ensuring they are specific, measurable, achievable, relevant, and time-bound (SMART). This approach guarantees that the VR scenario is designed with a clear purpose, making it easier to assess its effectiveness later. For instance, in a skill acquisition scenario, the primary objective might focus on learning a technical operation, while sub-objectives could detail steps like understanding the operational sequence, recognizing common errors, and practicing troubleshooting techniques. Similarly, for safety awareness, sub-objectives might include recognizing emergency signals, navigating safe escape routes, or properly using fire suppression tools. Each of these sub-objectives ensures that the

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user engages with different facets of the primary goal, leading to a comprehensive understanding of the topic. When aligning content with training goals, it's essential to consider the context and audience. Tailor the scenario to the users' background knowledge and expertise level. For example, a VR training module for novice users may include fundamental safety protocols with interactive guidance, while an advanced module for experienced professionals might simulate high-pressure situations that require quick decision-making. The scenario should also incorporate realistic challenges and feedback mechanisms to reinforce learning, such as immediate corrections for mistakes or rewards for completing tasks accurately. Moreover, defining objectives early helps streamline the design and development process. It ensures that every element of the scenario, from the environment to the interactivity, contributes meaningfully to the training goals. Objectives also act as benchmarks during testing and evaluation, providing a clear framework for measuring the scenario's impact on user performance and learning outcomes. By embedding these considerations into the objective-setting phase, developers can create VR scenarios that not only meet educational or training needs but also engage users in a memorable and effective way.

2. Understand Audience Needs:

- Profile the target audience to determine their familiarity with VR technology and subject matter.
- Adjust the complexity and interactivity based on user expertise.

Understanding the audience is a foundational step in designing effective VR scenarios. Begin by profiling the target audience, focusing on their familiarity with both VR technology and the subject matter. This includes evaluating their prior experience with virtual environments, understanding their comfort level with VR hardware, and assessing their knowledge of the scenario's content. For instance, a group of trainees new to VR may require more guided interactions and simplified navigation, while advanced users might benefit from highly interactive and complex scenarios. Similarly, the subject matter expertise of the audience should influence the depth and detail of the scenario. For example, novice users in a safety training scenario might need basic instructions on identifying hazards, while seasoned professionals could tackle advanced risk assessment and decision-making tasks. To create an optimal user experience, adjust the scenario's complexity and interactivity to match the audience's skill level. For beginners, focus on intuitive interactions and straightforward tasks. This might involve step-by-step instructions, highlighted objects, and limited decision paths to ensure users are not overwhelmed. In contrast, scenarios for experienced users can include non-linear paths, higher levels of interactivity, and challenging problem-solving tasks that test their expertise. For instance, an entry-level training might simulate a guided walkthrough of an emergency procedure, while an advanced scenario could simulate a time-critical crisis requiring independent decision-making and multitasking under pressure. Audience needs also extend to accessibility and inclusivity. Consider physical and cognitive differences among users and design controls and interfaces accordingly. Options such as adjustable text sizes, alternative input methods, and customizable settings enhance the

scenario's usability for a broader audience. Additionally, understanding the audience's preferred learning styles can inform the design. For example, some users may benefit from visual aids and simulations, while others might find audio instructions or interactive challenges more engaging. Finally, gather feedback from representative users during the development process. This iterative approach ensures that the scenario remains aligned with audience expectations and training goals. By deeply understanding the target audience and tailoring the VR experience to their needs, developers can create scenarios that are engaging, effective, and accessible, providing a meaningful and memorable training or learning experience.

3. Leverage Realism and Context:

- Use photorealistic or contextually accurate 3D models and environments.
- Emphasize fidelity to real-world conditions when training involves high-stakes applications like safety drills.

To maximize the effectiveness of VR scenarios, realism and contextual accuracy are paramount. Begin by using photorealistic or contextually accurate 3D models and environments that closely mimic the real-world settings in which the scenario is intended to be applied. High-quality textures, realistic lighting, and meticulously modeled objects contribute to an immersive experience that enhances the user's ability to transfer learned skills to real-world situations. For example, a training scenario for operating heavy machinery should replicate the exact controls, dimensions, and layout of the equipment, ensuring users can build confidence and familiarity within the virtual environment. Realism is especially critical in scenarios involving high-stakes applications, such as safety drills or emergency response training. Fidelity to real-world conditions ensures that users are prepared to respond effectively in actual crises. This includes replicating environmental factors such as smoke, fire, or low visibility in a fire safety scenario, or simulating hazardous conditions like chemical spills in an industrial safety training module. These elements not only enhance the authenticity of the experience but also expose users to the stress and sensory overload they might face in real-life situations, improving their readiness and decision-making skills. Contextual accuracy extends beyond the visual and environmental elements to include realistic interactions and dynamics. For instance, non-playable characters (NPCs) in a scenario should behave in ways that mirror real-world human behavior, such as panic or calm guidance during emergencies. Similarly, objects in the environment should respond to user actions in a manner consistent with physical laws, for instance a fire extinguisher should spray foam realistically, and doors should swing open or remain locked based on user decisions. This level of detail reinforces the user's trust in the simulation and deepens their engagement. Incorporating context also involves tailoring the scenario to the specific needs of the user's domain. For example, a healthcare training module might simulate the layout and equipment of an operating room, while a military scenario might recreate the terrain and operational conditions of a conflict zone. These elements ensure that the training is directly applicable to the user's real-world responsibilities and challenges. Lastly, realism must be balanced with performance considerations. While

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photorealism is desirable, it should not compromise the VR experience's smoothness and responsiveness. Optimization techniques, such as level-of-detail (LOD) scaling and efficient rendering practices, should be employed to ensure a seamless experience across devices. By leveraging realism and context effectively, VR scenarios can provide immersive, impactful, and applicable training experiences that bridge the gap between virtual practice and real-world application.

4. Interactive Design:

- Incorporate natural and intuitive interaction mechanisms, such as gaze-based selection or simple controller input.
- Ensure interactions align with the immersion level and available VR hardware.

Effective interactive design is essential for creating engaging and user-friendly VR scenarios. Begin by incorporating natural and intuitive interaction mechanisms that align with how users expect to interact with the virtual environment. These can include gaze-based selection, where users simply look at an object to interact with it, or simple controller inputs, such as pressing a button or moving a joystick. For example, gaze-based interactions are particularly effective in scenarios requiring minimal physical movement, making them ideal for accessibility-focused designs. Conversely, controller inputs allow for more complex interactions, such as grabbing objects, pressing switches, or navigating through a virtual space. The chosen interaction methods should be easy to learn and use, reducing cognitive load and frustration, especially for novice users. For instance, a training scenario for assembling machinery might allow users to select and place components with straightforward drag-and-drop mechanics using VR controllers. Similarly, voice commands can be integrated for hands-free interaction, enhancing the realism and usability of the scenario, particularly in environments like healthcare or emergency response training where verbal commands are part of real-world workflows. Aligning interactions with the immersion level and available VR hardware is another critical aspect of interactive design. For low-end VR devices with limited input capabilities, such as mobile-based headsets, prioritize simpler interaction methods like gaze selection or timed transitions. For high-end devices with advanced features like hand tracking or haptic feedback, leverage these capabilities to enhance interactivity. For example, scenarios on high-end platforms can allow users to manipulate objects directly with their hands or feel vibrations when interacting with virtual surfaces, further immersing them in the experience. To maintain immersion, interactions should be seamless and contextually relevant. Avoid overly complex controls or unnatural movements that break the user's sense of presence in the virtual environment. Feedback is also crucial; provide immediate visual, auditory, or haptic responses to user actions. For instance, highlighting objects that can be interacted with or providing a sound cue when an action is completed reinforces the user's understanding of the environment and keeps them engaged. Interactivity should also support the objectives of the scenario. For example, in a safety training simulation, users might interact with objects like fire extinguishers, doors, or emergency alarms. These interactions should mimic real-world actions as closely as possible to build muscle memory and ensure the skills learned in

VR transfer effectively to real-life situations. Lastly, test interactive elements extensively to ensure they work as intended and are intuitive for a wide range of users. Collect feedback during development to identify and resolve issues, and consider implementing adaptive interaction options to cater to users with varying levels of VR experience and physical abilities. By focusing on natural, intuitive, and hardware-aligned interactions, VR scenarios can deliver a smooth and engaging user experience that enhances learning and immersion.

Scenario Development Process

1. Scenario Planning:
    - Define the narrative or logical flow of the experience.
    - Create a scene graph to outline transitions between scenes based on user decisions.

Scenario planning is the foundational step in designing an effective VR experience. Begin by defining the narrative or logical flow of the scenario. A well-constructed narrative provides structure, purpose, and engagement, guiding the user through a coherent sequence of events. The storyline should align with the training or experiential goals of the scenario and include clear objectives and challenges. For instance, in a safety training simulation, the narrative might revolve around responding to an unfolding emergency, such as a fire or chemical spill, with the user making critical decisions at each stage.

The narrative should include decision points that affect the progression of the experience. These decision points introduce interactivity and ensure the scenario is dynamic and non-linear. For example, a user might choose between using an extinguisher to fight a fire or prioritizing evacuation. Each decision should lead to distinct consequences, such as escalating the fire in one path or encountering obstacles in the evacuation route in another. This approach keeps users engaged and provides opportunities for learning from both successes and mistakes.

Once the narrative is defined, create a scene graph to outline the flow and transitions between scenes. A scene graph is a visual representation of the scenario's structure, detailing the connections between various scenes based on user decisions. Each node in the graph represents a scene, such as entering a room, interacting with an object, or encountering a new challenge. The edges of the graph represent the transitions triggered by user actions, such as selecting an object, completing a task, or making a decision.

The scene graph should account for all possible user paths, including correct, partially correct, and incorrect choices. For example, if the scenario involves extinguishing a fire, one path might represent successful use of the extinguisher, another might depict failed attempts due to incorrect handling, and a third might escalate the situation due to inaction. Including such variations ensures the scenario is comprehensive and realistic.

Additionally, the scene graph should incorporate loops and fallback paths where

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appropriate. For instance, if a user makes an incorrect decision, the scenario might guide them back to a previous scene to try again or provide corrective feedback. However, to prevent infinite loops, exit criteria must be defined, such as a time limit or a maximum number of attempts, ensuring the scenario progresses meaningfully.

Tools such as diagrams.net, Coggle, or presentation software can be used to construct the scene graph. This visual representation serves as a blueprint for the development team, ensuring all components of the scenario are logically connected and aligned with the narrative. By meticulously planning the narrative and structure of the experience, developers can create a VR scenario that is engaging, educational, and capable of adapting to user decisions.

2. Environment Creation:

- Choose settings that align with the objectives, ensuring appropriate scale, lighting, and props.
- Optimize 3D assets for performance without compromising visual quality.

The creation of a realistic and engaging virtual environment is crucial for the success of any VR scenario. Start by selecting settings that align with the defined objectives of the scenario. The environment should be contextually appropriate, whether it's an office for corporate training, a manufacturing floor for industrial safety drills, or an emergency room for medical practice. Ensuring that the scale, layout, and design of the setting are accurate fosters immersion and provides a credible backdrop for the user's interactions and decision-making. Scale is a key consideration. Objects, rooms, and spaces must be designed to accurately reflect their real-world dimensions. For example, doorways, machinery, and furniture should be appropriately sized to match user expectations, as mismatched scales can disrupt immersion and impact the effectiveness of the training. For scenarios requiring user navigation, consider factors like hallway width, ceiling height, and the overall flow of the space to create a comfortable and realistic environment. Lighting plays a critical role in setting the tone and enhancing the realism of the environment. Use lighting that mimics real-world conditions, such as natural daylight for outdoor scenes or artificial lighting for indoor spaces. Dynamic lighting effects, like flickering fluorescent lights or the glow of a computer monitor, can add authenticity. However, ensure that lighting levels are appropriate for the scenario's objectives, for instance too much brightness or darkness may hinder visibility and detract from the experience. Props are equally important in grounding the user within the virtual environment. Include objects that are directly relevant to the scenario's tasks and objectives, such as tools, machinery, safety equipment, or everyday items. For instance, in a fire safety scenario, props might include fire extinguishers, smoke detectors, emergency signage, and evacuation maps. Attention to detail in the design of props, such as correct labeling, realistic textures, and functional interaction points, reinforces the sense of authenticity. Performance Optimization is essential to ensure that the VR experience runs smoothly across various devices and platforms. High-fidelity 3D assets can significantly enhance visual quality, but they must be optimized to avoid performance bottlenecks. Techniques

such as reducing polygon counts, implementing level-of-detail (LOD) models, and using efficient texture mapping help balance visual quality and performance. For example, distant objects can be rendered with lower detail while maintaining high resolution for items in the user's immediate view. Efficient Rendering practices, such as baked lighting for static scenes or instancing for repeated objects, can further enhance performance without noticeable loss in quality. Additionally, ensure compatibility with the target VR hardware. Lower-end devices may require more aggressive optimizations, while high-end systems can support more complex and detailed environments. Lastly, testing and iteration are crucial in environment creation. Conduct thorough testing to identify issues like clipping, incorrect scaling, or distracting visual elements. Gather feedback from users to refine the design, ensuring that the environment supports the scenario's objectives while providing an immersive and engaging experience. By focusing on alignment with objectives and careful optimization, developers can create environments that elevate the effectiveness and realism of VR scenarios.

3. Interaction Design:

- Specify key user interactions, such as object selection, decision points, and navigation.
- Design triggers for scene transitions, ensuring smooth and logical flow.

Interaction design is a critical component of VR scenario development, ensuring that users can engage meaningfully with the virtual environment while progressing through the experience seamlessly. Start by specifying the key user interactions required to achieve the scenario's objectives. These interactions might include selecting objects, making decisions at branching points, and navigating through the environment. For instance, in a fire safety training scenario, interactions could involve selecting the appropriate type of fire extinguisher, deciding on an evacuation route, or identifying hazards in the environment. Object Selection should be intuitive and aligned with the hardware capabilities of the target VR system. Gaze-based selection works well for hands-free experiences, where users can interact with objects by focusing on them for a brief period. For more advanced systems, controller-based interactions allow users to point, grab, or manipulate objects directly, enhancing the sense of agency. Additionally, hand-tracking technology can provide natural and immersive interaction by enabling users to physically reach out and interact with virtual objects. Decision Points are moments where users choose between different actions or paths, influencing the flow and outcome of the scenario. These should be designed to align with the scenario's objectives, providing meaningful choices that impact the narrative or learning experience. For example, in an emergency response scenario, users might decide whether to prioritize securing a hazard or assisting a colleague. These decisions should have clear consequences, reinforcing the importance of the choices made. Navigation within the virtual environment must be smooth and intuitive. Provide users with clear visual cues, such as arrows or highlighted paths, to guide them through the scenario. For larger environments, consider implementing teleportation mechanics or waypoint systems to prevent motion sickness and make navigation efficient. In smaller

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or static scenarios, natural walking or room-scale tracking can enhance immersion by allowing users to physically move within their space. Triggers for Scene Transitions are essential for ensuring a logical flow between scenes. These triggers should be tied to user actions, time-based events, or environmental changes. For example, successfully completing a task, such as extinguishing a fire, might trigger a transition to the next scene, where users assess the aftermath. Alternatively, failure to act within a specified timeframe could escalate the situation, presenting new challenges. Triggers should be clearly communicated to the user through visual, auditory, or haptic feedback to ensure they understand the cause of the transition. To maintain immersion, transitions between scenes should be seamless. Use fade-ins, fade-outs, or camera movements to mask loading times or shifts in the environment. Ensure that transitions align with the narrative, avoiding abrupt or confusing changes that could disrupt the user's experience. For example, transitioning from one room to another during an evacuation scenario might involve opening a door, which naturally leads the user into the next scene. Lastly, testing and refinement are key to effective interaction design. Test the interactions and transitions extensively to identify and resolve any usability issues. Gather feedback from users to understand how they perceive the interactions and make adjustments to improve intuitiveness and engagement. By carefully specifying interactions and designing smooth, logical triggers for scene transitions, developers can create VR scenarios that are both immersive and impactful, ensuring users remain engaged and focused on achieving the scenario's objectives.

4. Character and Prop Integration:
    - Include characters or objects relevant to the scenario goals.
    - Use characters to simulate realistic interactions or provide instructions.

The integration of characters and props in a VR scenario is vital for enhancing realism, interactivity, and alignment with the scenario's objectives. Begin by including characters and objects that are directly relevant to the goals of the simulation. For instance, in a medical training scenario, props might include surgical instruments, diagnostic devices, and hospital furniture, while characters could represent patients, doctors, or support staff. The presence of well-designed characters and props grounds the user in the virtual environment and supports the narrative, making the experience more immersive and effective. Characters serve multiple purposes in VR scenarios. They can simulate realistic interactions, such as communicating with the user, responding to their decisions, or performing tasks within the environment. For example, in an emergency response scenario, a character might act as a distressed individual requiring assistance, prompting the user to take specific actions. Non-playable characters (NPCs) can also serve as guides, providing instructions, feedback, or context to the user. For instance, a virtual instructor could offer step-by-step guidance in a complex assembly task or warn the user of hazards in a safety training module. To enhance realism, characters should exhibit lifelike behaviors and responses. This can be achieved by integrating artificial intelligence (AI) to enable adaptive dialogue, emotional expressions, and situationally appropriate actions. For example, a patient character in a healthcare simulation might

display symptoms, respond to user interactions, and adapt their behavior based on the user's choices, such as improving or worsening after treatment. These dynamic interactions create a richer, more engaging learning experience. Props should be carefully chosen to reflect the real-world tools and objects relevant to the scenario. High-quality, interactable props allow users to perform tasks that mirror their real-world counterparts. For instance, in a fire safety training scenario, props might include different types of fire extinguishers, fire alarms, and emergency exit signs. Each prop should be designed with attention to detail, including realistic textures, labels, and functionality. Props should not only look authentic but also behave realistically when interacted with, such as a fire extinguisher emitting foam when used correctly. When integrating characters and props, consider the interplay between them. Characters might interact with props during the scenario to demonstrate proper usage or to add context. For example, a firefighter character could show how to operate a fire extinguisher before the user attempts it themselves. Similarly, props might serve as cues for interactions with characters, such as presenting a clipboard for a user to hand to an NPC or using a medical scanner on a patient.

Placement and accessibility are also critical. Props and characters should be positioned logically within the environment to reflect real-world scenarios. For example, medical equipment should be placed near a hospital bed, while emergency tools should be located at accessible points in an industrial training scenario. Ensure that props are within easy reach of the user's virtual position and that their interaction mechanics are intuitive and aligned with the scenario's hardware capabilities. Finally, testing and iteration are key to achieving effective character and prop integration. Test the functionality and behavior of all characters and props within the scenario to ensure they perform as intended and support the learning objectives. Gather feedback from users to identify areas for improvement, such as adjusting the behavior of an NPC or refining the interaction mechanics of a prop. By thoughtfully integrating characters and props, VR developers can create scenarios that are immersive, interactive, and directly aligned with the objectives of the experience.

5. Multilevel Design:

- Incorporate different difficulty levels to accommodate varying expertise levels.
- Design progressive challenges to enhance user engagement.

Multilevel design in VR scenarios is essential for accommodating users with varying levels of expertise and ensuring sustained engagement throughout the experience. By incorporating multiple difficulty levels, scenarios can cater to beginners, intermediate users, and advanced participants, allowing for a tailored learning experience that meets individual needs. For example, a fire safety training module could offer an easy level where users practice basic evacuation procedures, a medium level that introduces moderate hazards like obstructed exits, and a hard level with complex challenges such as dense smoke and time-sensitive decisions. Incorporating Different Difficulty Levels begins with defining the specific skills or knowledge that each level should address. The easiest level

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should introduce fundamental concepts and basic tasks, ensuring accessibility for users with minimal experience. For instance, in an industrial safety scenario, this might involve simple identification of safety equipment and straightforward navigation through a controlled environment. Intermediate levels can build on these foundations, requiring users to make more decisions and respond to evolving conditions. Advanced levels should push users to apply their knowledge in high-pressure or unpredictable situations, simulating the complexity and stakes of real-world scenarios. Progressive Challenges are crucial for maintaining user engagement and fostering skill development. Each level should build on the previous one, gradually increasing in complexity and intensity. This progression keeps users motivated while avoiding frustration or boredom. For example, in a medical training scenario, an easy level might involve diagnosing a single patient with clear symptoms, while higher levels introduce multiple patients, ambiguous symptoms, and time constraints. These layered challenges ensure users remain engaged and are continuously encouraged to refine their skills. To enhance engagement, consider introducing adaptive difficulty mechanisms. These systems adjust the level of challenge dynamically based on the user's performance. For example, if a user is excelling at identifying hazards in a safety scenario, the system could introduce additional hazards or shorten decision-making time. Conversely, if a user is struggling, the system might provide hints or simplify the tasks. This approach ensures the scenario remains challenging yet achievable, providing a personalized learning experience. Designing Levels also involves careful consideration of the environment, props, and interactions. Ensure that each level introduces new elements to keep the experience fresh and stimulating. For instance, in an evacuation training module, the easy level might feature well-lit, unobstructed paths, while higher levels incorporate darkened environments, blocked exits, and realistic distractions like panicked NPCs or loud alarms. These changes not only increase difficulty but also deepen immersion and realism. Evaluation Metrics should be tailored to each difficulty level to provide meaningful feedback. At easier levels, evaluations might focus on task completion and understanding of basic principles, while advanced levels assess decision-making speed, accuracy, and the ability to handle multiple variables simultaneously. Providing users with detailed feedback after each level reinforces learning and highlights areas for improvement. Lastly, testing and user feedback are essential for refining multilevel designs. Test each level extensively to ensure that the progression is logical and that the challenges are appropriately scaled. Gather feedback from users of varying expertise to understand their experience with each level and make adjustments as needed. By carefully designing multilevel experiences with progressive challenges, VR scenarios can offer an engaging and effective learning journey that accommodates diverse user needs and fosters continuous skill development.

6. Feedback and Evaluation:
    - Implement evaluation criteria to assess user performance.
    - Provide immediate and post-scenario feedback, such as scores or activity summaries.

Effective feedback and evaluation mechanisms are critical for measuring the success of a VR scenario and facilitating user learning. Begin by implementing clear evaluation criteria tailored to the objectives and complexity of the scenario. These criteria should reflect both the accuracy and efficiency of the user's actions. For example, in a safety training module, key performance indicators (KPIs) might include identifying hazards correctly, responding within an optimal time frame, and executing proper emergency protocols. Each KPI should be measurable, providing a quantifiable basis for assessing performance. Evaluation Criteria should be aligned with the difficulty level and specific tasks within the scenario. At beginner levels, criteria might focus on basic task completion, such as successfully navigating the environment or interacting with key objects. For more advanced levels, evaluation could include the quality of decisions made under pressure, adherence to procedural standards, and the ability to handle multiple challenges simultaneously. Weighting the criteria based on their importance to the scenario's objectives ensures that evaluations are meaningful and focused on critical competencies. Immediate Feedback during the scenario is essential for reinforcing correct actions and correcting mistakes in real time. This feedback can be visual (e.g., highlighting correct choices or displaying warning icons), auditory (e.g., sound effects or verbal cues), or haptic (e.g., controller vibrations). For example, in a fire evacuation scenario, users might receive immediate feedback if they attempt to open a blocked exit, such as a warning sound or a visual indicator showing the door is inaccessible. Immediate feedback helps users adjust their behavior on the fly, improving engagement and learning outcomes. Post-Scenario Feedback provides users with a comprehensive summary of their performance. This can include scores, activity logs, and detailed breakdowns of actions taken during the scenario. For instance, a report might show how many hazards were identified, the time taken to complete tasks, and any errors made along the way. Advanced feedback systems can include visualizations, such as heatmaps of user navigation or decision trees showing alternative paths and outcomes. These tools help users understand their performance in context and identify areas for improvement. Qualitative Feedback can also be integrated to complement quantitative evaluations. For example, users might receive narrative feedback from virtual instructors or characters, summarizing their overall performance and offering guidance for future attempts. This approach adds a personal and engaging touch, making the evaluation process feel less mechanical and more relatable. Long-Term Tracking of user performance across multiple sessions can be implemented for scenarios used in training programs or certifications. By recording scores and progress over time, users and instructors can monitor improvement and identify persistent challenges. This data can also inform adjustments to the scenario, ensuring it remains effective and relevant. Finally, iterative refinement of feedback and evaluation mechanisms is crucial. Test the system with real users to ensure the criteria are clear and meaningful, and that the feedback is timely and actionable. Collect user feedback to understand their experience with the evaluation process and refine it to better meet their needs.

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By providing immediate and post-scenario feedback that is detailed, constructive, and aligned with performance criteria, VR scenarios can drive meaningful learning and skill development while keeping users engaged and motivated.

Best Practices for Implementation

1. Iterative Development:
    - Test scenarios iteratively to refine user experience and eliminate bugs.
    - Involve end-users in testing phases for actionable feedback.

Iterative development is a cornerstone of creating effective and user-centered VR scenarios. This approach involves designing, testing, and refining the scenario in cycles, allowing developers to identify and address issues progressively. Begin by creating a basic prototype or initial version of the scenario that includes the core elements, such as the environment, interactions, and narrative flow. This prototype serves as the foundation for iterative refinement. Testing Scenarios Iteratively is essential for ensuring a seamless user experience and eliminating bugs. Each iteration should focus on specific aspects of the scenario, such as visual fidelity, interaction mechanics, or scene transitions. For instance, an initial iteration might test the basic functionality of navigation and object interactions, while subsequent iterations address the realism of character behaviors or the alignment of lighting and sound effects. By isolating components in each cycle, developers can pinpoint and resolve issues efficiently, preventing them from compounding as the scenario becomes more complex. End-User Involvement is critical during the testing phases to gather actionable feedback and ensure the scenario meets the needs of its intended audience. Involve a diverse group of users representing the target demographic, including individuals with varying levels of familiarity with VR and the subject matter. This inclusivity ensures the scenario is accessible and effective for all users. For example, in a medical training scenario, include both novice healthcare students and experienced practitioners in testing to capture a broad range of perspectives. During user testing, focus on collecting both qualitative and quantitative feedback. Qualitative feedback might include observations about the scenario's intuitiveness, realism, and engagement level, while quantitative metrics could track task completion rates, error frequencies, and time spent on specific activities. Tools like usability surveys, performance analytics, and direct user interviews can provide valuable insights into areas that require improvement. Incorporating Feedback is the next step in the iterative process. Analyze the data gathered from testing to identify patterns and prioritize changes. For instance, if multiple users report difficulty navigating the environment, consider adding clearer visual cues or simplifying movement mechanics. Similarly, if interactions with objects feel unnatural, refine the input methods to align with user expectations. Each round of feedback should guide specific adjustments, gradually refining the scenario to achieve its intended objectives. Continuous Iteration ensures the scenario remains adaptable and relevant. Even after the scenario's initial release, periodic updates can address emerging user needs, integrate new technologies, or reflect changes in the real-world context it simulates. This

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ongoing development process not only enhances the scenario's effectiveness but also sustains user engagement over time. Finally, maintain detailed documentation of each iteration, including the changes made, issues resolved, and new features added. This documentation provides a clear development history, streamlines collaboration among team members, and supports future scalability.

By adopting an iterative approach and actively involving end-users, developers can create VR scenarios that are polished, user-focused, and impactful, delivering an exceptional experience that meets both technical and educational goals.

2. Lighting and Time Control:

- Use artificial lighting for consistent visual quality and recording flexibility.
- Avoid real-time environmental changes that may disrupt scenario continuity.

Lighting and time control are pivotal in ensuring the visual consistency and overall quality of VR scenarios. Thoughtfully designed lighting not only enhances immersion but also supports the narrative and learning objectives by directing the user's attention to key elements within the virtual environment. Use Artificial Lighting to maintain consistent visual quality and maximize recording flexibility. Artificial lighting offers precise control over brightness, color temperature, and shadow placement, ensuring that all elements of the scene are evenly illuminated and visually coherent. For instance, in a training scenario set in an office environment, artificial lighting can replicate the effect of overhead fluorescent lights, creating a professional and realistic atmosphere. Similarly, in industrial or emergency settings, well-placed artificial lighting can simulate conditions like emergency lights or machinery illumination. This approach eliminates the variability associated with natural lighting, such as changes in intensity or direction throughout the day, which could disrupt the scenario's consistency. Artificial lighting also allows for greater creative flexibility. Developers can use accent lighting to highlight important props or areas, such as emergency exits or interactive objects, guiding the user's focus and supporting the narrative flow. Dynamic lighting effects, like flickering lights in a fire evacuation scenario, can add to the realism and urgency of the experience without sacrificing control over the visual environment. Avoid Real-Time Environmental Changes that could disrupt the continuity of the scenario. In scenarios where day-night cycles, weather patterns, or other time-sensitive elements might be relevant, it's crucial to pre-record or simulate these changes rather than relying on real-time adjustments. For example, a virtual environment with changing daylight could lead to inconsistencies in visual quality if certain parts of the scenario are darker or harder to see due to the time of day. Users might also misinterpret these changes as indicators of progression or varying difficulty levels, detracting from the intended experience. Predefined environmental conditions ensure that all users encounter the same visual and interactive experience, regardless of when or how they access the scenario. For instance, if a fire safety training module uses a sequence of escalating hazards, keeping the lighting and environmental factors consistent ensures that the focus remains on the user's actions and decisions rather than the variability of the surroundings. This consistency is particularly important

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for scenarios used in formal assessments or certifications, where uniform conditions are necessary to ensure fairness and reliability. Performance Optimization should also be considered when implementing lighting and time control. While dynamic lighting effects can enhance realism, they are computationally intensive and may impact the performance of the VR experience. Techniques like baked lighting, where light and shadows are pre-rendered into the scene, can provide high-quality visuals with minimal performance overhead. Similarly, subtle animations or pre-recorded transitions can simulate environmental changes without introducing real-time variability. By using artificial lighting and avoiding disruptive real-time environmental changes, developers can create visually consistent and engaging VR scenarios that support the learning objectives and maintain a seamless user experience. These practices ensure that users remain focused on the task at hand, free from distractions caused by unnecessary variability or inconsistencies in the virtual environment.

3. Error Management:

- Design responses for critical user errors, such as in-scene corrective guidance or scenario termination.
- Ensure failure points are teachable moments.

Effective error management in VR scenarios is crucial for fostering learning and engagement. Errors, when handled appropriately, can become valuable teaching opportunities, helping users understand their mistakes and learn correct behaviors. Begin by designing responses for critical user errors that align with the scenario's objectives and context. These responses should be constructive and encourage users to reflect on their actions, promoting better decision-making in future attempts. Design Responses for Critical Errors by implementing in-scene corrective guidance or scenario termination, depending on the severity of the error. For example, in a fire safety training scenario, if a user selects an incorrect fire extinguisher for a specific fire type, the system could provide immediate feedback through visual cues (e.g., highlighting the correct extinguisher) or audio prompts (e.g., a virtual instructor explaining the correct choice). This corrective guidance allows users to identify and address their mistakes in real time, reinforcing proper actions without disrupting the flow of the scenario. For more severe errors that compromise the scenario's progression, such as ignoring an escalating hazard or failing to complete a critical task, scenario termination may be necessary. However, even in these cases, termination should be designed as a teachable moment. For instance, the scenario could end with a detailed explanation of the consequences of the user's actions, accompanied by recommendations for improvement. For example, in an evacuation drill, failing to identify a safe escape route might result in the scenario ending with a simulation of the consequences (e.g., becoming trapped) and suggestions for how to better assess escape options in the future. Ensure Failure Points Are Teachable Moments by integrating learning opportunities into the error management process. Instead of simply penalizing users for mistakes, provide feedback that encourages them to reflect on their decisions and understand the rationale behind the correct actions. For example, in a medical training scenario, if a user fails to administer the correct dosage of

medication, the system could explain the potential consequences of their error, followed by a demonstration of the correct procedure. This approach transforms failures into learning experiences, helping users build confidence and competence. Adaptive Error Management can further enhance the learning process. By monitoring user performance and adjusting the level of guidance dynamically, the scenario can provide additional support to struggling users while allowing more experienced participants to proceed with minimal intervention. For example, if a user repeatedly makes the same error, the system could offer step-by-step guidance or reduce the complexity of the task temporarily to help them succeed. Encourage Experimentation by creating a safe virtual environment where users feel comfortable making mistakes. Clearly communicate that errors are part of the learning process and that the goal is to improve through practice. This approach is particularly important in high-stakes scenarios, such as emergency response training, where real-world consequences can be severe. By allowing users to explore different actions and observe their outcomes without fear of failure, VR scenarios can foster a deeper understanding of the subject matter. Finally, Evaluate and Refine Error Responses through user testing and feedback. Analyze how users respond to error management mechanisms and whether they lead to improved performance in subsequent attempts. Use this data to refine the feedback and guidance provided, ensuring that it effectively supports learning objectives. By designing thoughtful responses to errors and framing failure points as opportunities for growth, VR scenarios can create a supportive and impactful learning environment that helps users develop skills and confidence.

4. Accessibility and Usability:

- Make scenarios accessible to users with varying physical abilities.
- Provide clear instructions and intuitive navigation aids.

Accessibility and usability are fundamental aspects of VR scenario design, ensuring that all users, regardless of their physical abilities or experience with VR, can engage meaningfully with the content. By prioritizing inclusive design and intuitive features, developers can create scenarios that are effective and enjoyable for a diverse audience. Make Scenarios Accessible to Users with Varying Physical Abilities by incorporating features that address a broad range of needs. For users with limited mobility, provide options for seated experiences or allow navigation using gaze-based controls rather than requiring physical movement. For instance, instead of relying on extensive walking or hand gestures, scenarios can include teleportation mechanics or single-button inputs for interactions. Similarly, ensure that key elements, such as interactive objects and visual cues, are positioned within a reasonable reach for both seated and standing users. For users with sensory impairments, offer alternative means of engagement. For example, include subtitles for auditory instructions and dialogues to support users who are hard of hearing. For visually impaired users, provide audio descriptions of the environment and objects, or integrate haptic feedback to convey spatial information. These accommodations not only enhance accessibility but also make the scenario richer and more engaging for all users. Provide Clear Instructions and Intuitive Navigation Aids to minimize confusion and reduce the learning curve for new users. Begin with a

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comprehensive tutorial or onboarding process that introduces the controls, interactions, and objectives of the scenario. For example, a step-by-step introduction to using a VR controller's buttons, combined with visual prompts, can help users become familiar with the interface before engaging with the scenario's core tasks. Navigation aids are particularly important for maintaining usability in complex environments. Use clear visual markers, such as arrows, paths, or highlighted areas, to guide users through the scenario. Interactive maps or waypoints can provide additional orientation in larger virtual spaces, ensuring that users do not become disoriented. For instance, in a fire evacuation scenario, illuminated exit signs and directional arrows can help users identify safe routes quickly. Intuitive Design extends to the layout and interactions within the scenario. Avoid cluttered environments that can overwhelm users or obscure critical elements. Interactive objects should stand out visually, perhaps through glowing edges or distinct colors, to indicate their importance. Interaction mechanics, such as grabbing, pointing, or selecting, should feel natural and consistent throughout the scenario, reducing the cognitive load on users. Customizable Settings are another essential feature for accessibility and usability. Allow users to adjust settings such as text size, audio volume, and interaction sensitivity to suit their preferences. For example, users with limited hand strength might benefit from reduced grip force requirements on VR controllers, while users with color vision deficiencies could benefit from alternative color schemes. Testing with Diverse Users is crucial to identify and address accessibility and usability challenges. Involve individuals with varying physical abilities, sensory impairments, and levels of experience with VR during the development process. Their feedback will provide valuable insights into potential barriers and opportunities for improvement, ensuring that the scenario meets the needs of all users. Finally, document accessibility features and provide clear guidance for users and instructors. This documentation can help users customize their experience and ensure that trainers or facilitators are aware of the scenario's inclusivity options. By prioritizing accessibility and usability, VR scenarios can deliver meaningful and engaging experiences to a wide range of users, fostering inclusion and maximizing the impact of the training or educational content.

5. Data Collection:

- Log user actions, decisions, and outcomes for evaluation.
- Optionally record user sessions for detailed performance review.

Data collection is an essential component of VR scenario design, providing the means to evaluate user performance, measure learning outcomes, and refine the scenario based on empirical evidence. Effective data collection involves logging user interactions and, optionally, recording entire sessions for a comprehensive analysis of behavior and decision-making processes. Log User Actions, Decisions, and Outcomes for Evaluation to gather detailed insights into how users interact with the scenario. This logging should include key metrics such as the sequence of actions performed, time taken to complete tasks, frequency of errors, and decision points. For example, in a medical training scenario, logs might track how quickly a user identifies symptoms, the sequence of tools they use, and whether they follow the correct treatment protocol. These metrics can

be used to assess individual performance, identify common challenges, and evaluate the scenario's overall effectiveness. Decision logging is particularly important for scenarios involving multiple pathways or outcomes. Record the choices users make at critical decision points, as well as the resulting consequences within the scenario. For instance, in a fire safety training module, logs might capture whether a user prioritizes extinguishing a fire or evacuating, and whether their decision leads to a successful outcome. This information can help trainers or evaluators understand the rationale behind user actions and provide targeted feedback. Optionally Record User Sessions to enable detailed performance review. Video recordings or playback of user sessions can provide a richer context for understanding behavior and decision-making. For example, in a team-based VR scenario, session recordings might reveal how users communicate and collaborate, highlighting strengths and areas for improvement. Similarly, in individual training, recordings can show how users navigate the environment, interact with objects, and respond to challenges. Recording sessions also supports reflective learning, allowing users to review their own performance and identify mistakes or missed opportunities. For example, a user reviewing a session in a hazard identification scenario might notice areas they overlooked, prompting greater attentiveness in future attempts. Trainers or evaluators can also use recordings to provide more personalized and actionable feedback, pinpointing specific moments where the user excelled or struggled. Data Privacy and Security are critical considerations when collecting and storing user data. Ensure that all data is anonymized to protect user identity, especially in scenarios involving sensitive information, such as healthcare training. Implement secure storage practices and provide clear information about how data will be used, giving users the option to consent to or opt out of data collection. Visualization and Reporting tools can enhance the utility of collected data. Use heatmaps to show user movement patterns within the environment, decision trees to illustrate pathways and outcomes, or graphs to track performance trends over time. These visualizations make it easier to identify patterns and insights, whether for individual users, groups, or the scenario as a whole. Iterative Scenario Refinement is another key benefit of data collection. By analyzing aggregated data, developers can identify areas where users commonly face difficulties, such as overly complex interactions or unclear instructions. This feedback can guide adjustments to the scenario, improving its effectiveness and usability for future users. By systematically logging actions, decisions, and outcomes, and optionally recording sessions for detailed review, VR scenarios can provide robust tools for evaluating performance and supporting both user learning and scenario development. These practices ensure that the data collected is actionable, secure, and aligned with the objectives of the VR experience.

Tools and Resources

- Scene Graph Tools:
  - Diagrams.net, Coggle, or PowerPoint for flow diagram creation.
- 3D Asset Management:

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- Use optimization tools to balance performance and quality.

- Evaluation Metrics:
  - Develop criteria for scoring based on objectives and sub-objectives.

Conclusion

Static 3D VR scenarios provide a structured yet immersive way to train and educate users. By following these best practices, developers can create scenarios that are engaging, effective, and aligned with organizational goals. Through iterative design and attention to user needs, VR can bridge the gap between theoretical knowledge and practical application.

Best Practices for Creating VR Dynamic and Interactive 3D Scenarios

Introduction

Dynamic and interactive VR scenarios represent a cutting-edge approach to virtual training and simulation, enabling real-time user engagement and responsive environments. Unlike static VR experiences, these scenarios adapt to user actions and decisions, creating a highly immersive and personalized experience. This interactivity is particularly beneficial in domains where decision-making under pressure, situational awareness, and procedural skills are critical. For example, dynamic VR can simulate emergency response situations, intricate surgical procedures, or complex industrial operations, providing users with realistic challenges that mimic real-world conditions. The emphasis lies in creating flexible scenarios that cater to a diverse range of learning objectives while fostering deep user immersion and active participation.

Key Principles

Setting clear objectives is fundamental to the success of a VR scenario, providing a structured framework that guides both development and user engagement. First, Define the Primary Goal and Sub-Goals of the Interactive Scenario. The primary goal serves as the overarching purpose of the simulation, whether it's mastering a specific skill, enhancing safety protocols, or improving decision-making. For example, a primary goal in a surgical training scenario might be to ensure the user can perform a specific operation safely and efficiently. Sub-goals, on the other hand, break this down into smaller, measurable components, such as understanding the surgical steps, handling tools correctly, or responding to unexpected complications. By clearly defining these goals, developers can align every aspect of the scenario with its intended purpose, ensuring a cohesive and targeted experience. Then align scenario design with practical outcomes. The design of the scenario should directly support real-world applications. For instance, in a fire safety scenario, the interactive elements might include identifying

fire hazards, selecting the correct extinguisher, and following evacuation routes under simulated pressure. Practical outcomes, such as improved hazard identification and faster response times, provide tangible benefits to the user and make the scenario valuable in professional settings. This alignment ensures that users not only engage with the VR experience but also gain skills and insights that translate effectively into real-world performance. By defining and aligning objectives early in the development process, VR scenarios can deliver focused, impactful, and measurable learning experiences that address the specific needs of their audience.

Adaptability is a cornerstone of dynamic and interactive VR scenarios, enabling a personalized and engaging experience that responds to user decisions and actions. Designing for adaptability ensures that each user's journey through the scenario is unique, enhancing both engagement and learning outcomes by mirroring the complexity of real-world situations. Create Modular Scenarios that Adapt to User Decisions and Actions. Modular design involves breaking the scenario into discrete, interchangeable components or modules. Each module represents a specific task, challenge, or environment that can be dynamically activated based on user input or behavior. For example, in a disaster response scenario, modules could include assessing the situation, deploying resources, or rescuing victims. If a user prioritizes resource deployment, the system could dynamically activate a corresponding module, adjusting the narrative and tasks accordingly. This modular approach allows developers to create flexible scenarios that accommodate a wide range of user strategies and skill levels without requiring a complete redesign for every possible outcome. Modular scenarios also make iterative development and updates more manageable. New modules can be added or existing ones modified without disrupting the overall structure, ensuring that the scenario remains relevant and scalable over time. Include Branching Paths to Reflect Varying Outcomes Based on User Behavior. Branching paths introduce decision points that lead to different outcomes, creating a non-linear experience where user choices have meaningful consequences. For example, in a medical training scenario, a user might choose between administering two different treatments. Each choice would lead to a unique path, such as patient improvement or complications, encouraging users to think critically about their decisions. Branching paths not only increase the complexity and realism of the scenario but also enhance replayability. Users can explore alternative paths in subsequent sessions, gaining a deeper understanding of the material and improving their decision-making skills. To ensure the branches remain coherent and purposeful, developers should map them out using scene graphs or flowcharts, clearly defining the relationships between decision points and their outcomes. Adaptive design also benefits from incorporating context-sensitive responses. For instance, the scenario might escalate challenges dynamically based on user performance, such as introducing additional hazards or time constraints for advanced users. Conversely, for users who struggle, the system might simplify tasks or provide hints, ensuring that the experience remains engaging and achievable for all participants. By creating modular, branching scenarios that adapt to user actions and decisions, VR experiences can replicate the unpredictability and complexity of real-world environments. This approach not only

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enhances immersion and engagement but also ensures that users develop skills and strategies that are directly applicable to their professional or educational contexts.

1. Prioritize Realism and Immersion:
   - Utilize high-fidelity 3D models and environments to simulate real-world conditions.
   - Incorporate dynamic lighting, sound, and environmental effects to enhance immersion.
2. User-Centric Interaction:
   - Design intuitive interaction mechanisms such as natural hand gestures, voice commands, or gaze-based input.
   - Provide contextual feedback to guide users through the scenario.

Scenario Development Process

1. Narrative and Logic Design:
   - Develop a compelling narrative with decision points to drive engagement.
   - Outline a scenario graph detailing possible paths, interactions, and outcomes.
2. Environment Development:
   - Design environments that respond dynamically to user actions (e.g., objects reacting to touch or environmental changes based on user decisions).
   - Optimize environments for performance without compromising on detail.
3. Dynamic Interactions:
   - Implement triggers that adapt the scenario based on user behavior, such as time-based events or performance metrics.
   - Enable real-time changes in the environment, such as weather effects or object transformations.
4. Behavioral AI Integration:
   - Utilize AI for non-playable characters (NPCs) to simulate realistic behaviors and interactions.
   - Ensure NPCs react contextually to user decisions and environmental changes.
5. Customization and Difficulty Levels:
   - Allow for customization of scenarios to meet individual user needs.
   - Incorporate multiple difficulty levels with distinct challenges.
6. Feedback Mechanisms:
   - Provide real-time feedback during the scenario to reinforce learning.

- Offer detailed post-scenario analytics, including decision logs and performance summaries.

Best Practices for Implementation

1. Iterative Testing:
   - Conduct extensive usability testing with end-users to refine interactions and scenario logic.
   - Address performance bottlenecks and ensure smooth transitions between scenes.
2. Immersive Audio and Visuals:
   - Leverage spatial audio and detailed visuals to create a believable and engaging environment.
   - Ensure consistent quality across devices and platforms.
3. Error Management and Recovery:
   - Include mechanisms to address user errors without disrupting the flow (e.g., hints or undo options).
   - Allow for scenario replay to reinforce learning from mistakes.
4. Accessibility:
   - Design scenarios to be inclusive, catering to users with varying physical and cognitive abilities.
   - Offer alternative control schemes and customizable settings.
5. Data Logging and Analytics:
   - Track user actions, decisions, and outcomes to provide meaningful feedback.
   - Use analytics to improve scenario design and measure learning outcomes.

Tools and Resources

- Development Tools:
  - Unreal Engine, Unity, or proprietary VR development platforms for creating interactive environments.
- AI and Interaction Libraries:
  - Use plugins or APIs for advanced AI behavior and interaction handling.
- Performance Optimization:
  - Tools for reducing rendering load while maintaining visual fidelity.

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Conclusion

Dynamic and interactive VR scenarios offer unparalleled opportunities for experiential learning and skill acquisition. By adhering to these best practices, developers can create compelling and effective simulations that not only engage users but also achieve specific educational or training objectives. Iterative design, user-focused interactions, and adaptive environments are key to unlocking the full potential of VR technology.

Attachment 1 – Example scenarios

SCENARIO 1

test film script

BRIEF DESCRIPTION OF THE SITUATION:

Illegal crossing of the pasture boundary in a forested area.

DAY-TIME:

Day (visibility good).

LOCATION:

Forest, a firebreak about 200 m in size near the forest road.

POSTINGS:

- MALE - PRESIDENT No. 1 - A man who looks dangerous (a hoodlum, a “neck”). Age about 35, massive but not powerful, wearing jeans and a sweatshirt, nothing very distinctive. He may have tattoos.
- MALE SMUGGLER DRIVER. A man who looks standard. Age about 45, dressed in cloth pants shirt and sweater, nothing very distinctive.
- MALE OCCASIONALIST No. 1 Asian, Arab or resident of the former USSR, of small stature. Age about 25, dressed in cloth pants shirt and sweater.
- MALE OCCASIONALIST No. 2 - Asian, Arab or resident of the former USSR, of small stature. Age about 50, dressed in pants and shirt.
- MALE OCCASIONALIST #3 Asian, Arab or resident of the former USSR, of small stature. Age about 15 years, dressed in pants and sweatshirt.

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EQUIPMENT:

VEHICLE - Bus of any brand, used, built-in cargo section (without windows).

NUMBER OF OFFICERS:

BORDER GUARD - TRAINED - Not visible on the screen (CAMERA is the point of view of the guard).

BORDER WATCHMAN - ADAM - Standard duty equipment.

WEAPON USED (ON SCREEN):

- KNIGHT - bayonet, length about 20 cm

SCENE 1 (S1)

From a distance of about 200 meters, the trainee observes 5 people illegally crossing the border. He moves towards them together with a fellow patrolman. At this time, 2 men help the three OBCRATIANS enter the cargo section of a bus parked on a forest road. THE DRIVER'S CHAIRMAN approaches the vehicle door from the driver's side but does not get into the vehicle. CHAIRMAN 1 closes the rear door of the car. At this point, the officers proceed to take action.

Situation time: about 20-25 s

SCENE 2 (S2)

TRAINED FUNCTIONER (CAMERA) comes closer. He is 5 steps ahead of the situation.

Situation time: about 5 s

SCENE 3 (S3) (Scenes S1, S2, S3 shot in one take)

SPEAKER 1 says, "What do you want? Documents? Coming right up." He reaches into his back pocket at this point.

Situation time: about 3 s

REACTION OF THE GUARD AT THE TRAINING

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OPTION 1

SCENE 4 (S4)

THE TRAINED GUARD in a firm voice issues the commands HANDS OFF, LOWER DOWN, HANDS ON PLEASURES, directing the weapon towards GUARD 1, who obeys the commands.

Situation time: about 8 s

SCENE 5 (S5)

At this time, the BORDER GUARD - ADAM points his gun at the DRIVER'S CHAIRMAN, issuing in a firm voice the command to slowly exit the vehicle, lie down on the ground with his hands on his back. The DRIVER'S CHAIRMAN obeys the command. END OF EXERCISE.

Situation time: about 8 s

OPTION 2

SCENE 6 (S6)

TRAINED WATCHMAN fires a shot in the direction of CHAIRMAN 1. CHAIRMAN 1 falls to the ground. THE TRAINED RANGER falls to the ground. END OF EXERCISE .

Situation time: about 3 s

SCENE 7 (S7)

TRAINED WATCHMAN takes no action, gives no orders. TRAINED GUARD 1 removes documents from his pants pocket and hands them to the BORDER GUARD - ADAM.

Situation time: about 4 s

SCENE 8 (S8)

BORDER GUARD - ADAM reaches out for a document and is overpowered. TRAINED GUARD 1 positions himself behind the officer's back and puts a knife to his throat. He then shouts that he will kill the officer if the TRAINED WATCHMAN does not put his weapon on the ground and move away.

Situation time: about 30 s

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SCENE 9 (S9)

BORDER WATCHMAN - ADAM HITS THE INTERVIEWER 1 with his heel on the tibia and leans over.

Situation time: about 2 s

SCENE 10 (S10)

TRAINED WATCHMAN fires a shot in the direction of CHAIRMAN 1, hits. CHAIRMAN 1 falls to the ground. THE TRAINED RANGER falls to the ground. END OF EXERCISE.

Situation time: about 10 s

OPTION 3

SCENE 11 (S11)

TRAINED WATCHMAN takes no action, gives no orders. TRAINED GUARD 1 removes documents from his pants pocket and hands them to the BORDER GUARD - ADAM.

Situation time: about 4 s

SCENE 12 (S12)

BORDER GUARD - ADAM reaches out for a document and is overpowered. TRAINED GUARD 1 positions himself behind the officer's back and puts a knife to his throat. He then shouts that he will kill the officer if the TRAINED WATCHMAN does not put his weapon on the ground and move away.

Situation time: about 30 s

SCENE 13 (S13)

BORDER WATCHMAN - ADAM HITS THE INTERVIEWER 1 with his heel on the tibia and leans over.

Situation time: about 3 s

SCENE 14 (S14)

THE TRAINED WATCHMAN does not react. TRAINED GUARD 1 stabs the KNIFE into the back of TRAINED GUARD ADAM and covers himself with his body. END OF EXERCISE.

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Situation time: about 4 s

OPTION 4

SCENE 15 (S15)

TRAINED WATCHMAN takes no action, gives no orders. TRAINED GUARD 1 removes documents from his pants pocket and hands them to the BORDER GUARD - ADAM.

Situation time: about 4 s

SCENE 16 (S16)

BORDER GUARD - ADAM reaches out for a document and is overpowered. TRAINED GUARD 1 positions himself behind the officer's back and puts a knife to his throat. He then shouts that he will kill the officer if the TRAINED WATCHMAN does not put his weapon on the ground and move away.

Situation time: about 30 s

SCENE 17 (S17)

BORDER WATCHMAN - ADAM HITS THE INTERVIEWER 1 with his heel on the tibia and leans over.

Situation time: about 3 s

SCENE 18 (S18)

TRAINED WATCHMAN shoots and misses. TRAINED GUARD 1 thrusts his KNIFE into the back of TRAINED GUARD ADAM and covers himself with his body. END OF EXERCISE.

Situation time: about 4 s

SCENARIO 1

LIST OF SCENES UNDER. IMPLEMENTATION SCENARIO "Illegal crossing of the pasture border in a forested area".

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LP.	CODE FROM THE SCRIPT	BRIEF DESCRIPTION OF THE SCENE
1	S1	PREMISES cross the border
2	S2	Officers are approaching the PREMISES
3	S3	CHAIRMAN 1 reaches into his pants pocket.
		OPTION 1
4	S4	EXERCISE gives firm commands.
5	S5	BORDER WATCHMAN - ADAM gives orders.
		OPTION 2
6	S6	THE EXERCISE takes a shot in the direction of PRESIDENT 1.
7	S7	EXERCISE does not take action.
8	S8	BORDER GUARD - ADAM is overpowered.
9	S9	BORDER WATCHMAN - ADAM strikes back at PREMIERE 1.
10	S10	The EXERCISE takes a shot in the direction of CHAMPION 1, hits.
11	S11	EXERCISE does not take action.
		OPTION 3
12	S12	BORDER GUARD - ADAM is overpowered.
13	S13	BORDER WATCHMAN - ADAM strikes back at PREMIERE 1.
14	S14	EXERCISE does not respond.
		OPTION 4
15	S15	EXERCISE does not take action.
16	S16	BORDER GUARD - ADAM is overpowered.
17	S17	BORDER WATCHMAN - ADAM strikes back at PREMIERE 1.
18	S18	THE EXERCISE takes a shot in the direction of CHAMPION 1 and misses.

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SCENARIO 1.1.

test film script

BRIEF DESCRIPTION OF THE SITUATION:

Illegal crossing of the pasture boundary in a forested area.

PORA:

Night (visibility limited).

LOCATION:

Forest, a firebreak about 200 m in size near the forest road.

POSTINGS:

- MALE - PRESIDENT No. 1 - A man who looks dangerous (a hoodlum, a "neck"). Age about 35, massive but not powerful, wearing jeans and a sweatshirt, nothing very distinctive. He may have tattoos.
- MALE SMUGGLER DRIVER. A man who looks standard. Age about 45, dressed in cloth pants shirt and sweater, nothing very distinctive.
- MALE OCCASIONALIST No. 1 Asian, Arab or resident of the former USSR, of small stature. Age about 25, dressed in cloth pants shirt and sweater.
- MALE OCCASIONALIST No. 2 - Asian, Arab or resident of the former USSR, of small stature. Age about 50, dressed in pants and shirt.
- MALE OCCASIONALIST #3 Asian, Arab or resident of the former USSR, of small stature. Age about 15 years, dressed in pants and sweatshirt.

EQUIPMENT:

VEHICLE - Bus of any brand, used, built-in cargo section (without windows).

NUMBER OF OFFICERS:

BORDER GUARD - TRAINED - Not shown on screen (CAMERA is the point of view of the guard).

BORDER GUARD - ADAM - Standard duty equipment + flashlight.

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WEAPON USED (ON SCREEN):

- KNIGHT - bayonet, length about 20 cm

SCENE 1 (S1)

From a distance of about 200 meters, the trainee observes 5 people illegally crossing the border. He moves towards them together with a fellow patrolman. At this time, 2 men help the three OBCRATIANS enter the cargo section of a bus parked on a forest road. THE DRIVER'S CHAIRMAN approaches the vehicle door from the driver's side but does not get into the vehicle. CHAIRMAN 1 closes the rear door of the car. At this point, the officers proceed to take action.

Situation time: about 20-25 s

SCENE 2 (S2)

TRAINED FUNCTIONER (CAMERA) comes closer. He is 5 steps ahead of the situation.

Situation time: about 5 s

SCENE 3 (S3) (Scenes S1, S2, S3 shot in one take)

SPEAKER 1 says, "What do you want? Documents? Coming right up." He reaches into his back pocket at this point.

Situation time: about 3 s

REACTION OF THE GUARD AT THE TRAINING

OPTION 1

SCENE 4 (S4)

THE TRAINED GUARD in a firm voice issues the commands HANDS OFF, LOWER DOWN, HANDS ON THE BACK, directing the weapon toward GUARD 1, who obeys the commands.

Situation time: about 8 s

SCENE 5 (S5)

At this time, the BORDER GUARD - ADAM points his gun at the DRIVER'S INTERVIEWER, issuing

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in a firm voice the command to slowly exit the vehicle, lie down on the ground with his hands on his back. The DRIVER'S CHAIRMAN obeys the command. END OF EXERCISE.

Situation time: about 8 s

OPTION 2

SCENE 6 (S6)

TRAINED WATCHMAN fires a shot in the direction of CHAIRMAN 1. CHAIRMAN 1 falls to the ground. THE TRAINED RANGER falls to the ground. END OF EXERCISE .

Situation time: about 3 s

SCENE 7 (S7)

TRAINED WATCHMAN takes no action, gives no orders. TRAINED GUARD 1 removes documents from his pants pocket and hands them to the BORDER GUARD - ADAM.

Situation time: about 4 s

SCENE 8 (S8)

BORDER GUARD - ADAM reaches out for a document and is overpowered. TRAINED GUARD 1 positions himself behind the officer's back and puts a knife to his throat. He then shouts that he will kill the officer if the TRAINED WATCHMAN does not put his weapon on the ground and move away.

Situation time: about 30 s

SCENE 9 (S9)

BORDER WATCHMAN - ADAM HITS THE INTERVIEWER 1 with his heel on the tibia and leans over.

Situation time: about 2 s

SCENE 10 (S10)

TRAINED WATCHMAN fires a shot in the direction of CHAIRMAN 1, hits. CHAIRMAN 1 falls to the ground. THE TRAINED RANGER falls to the ground. END OF EXERCISE.

Situation time: about 10 s

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OPTION 3

SCENE 11 (S11)

TRAINED WATCHMAN takes no action, gives no orders. TRAINED GUARD 1 removes documents from his pants pocket and hands them to the BORDER GUARD - ADAM.

Situation time: about 4 s

SCENE 12 (S12)

BORDER GUARD - ADAM reaches out for a document and is overpowered. TRAINED GUARD 1 positions himself behind the officer's back and puts a knife to his throat. He then shouts that he will kill the officer if the TRAINED WATCHMAN does not put his weapon on the ground and move away.

Situation time: about 30 s

SCENE 13 (S13)

BORDER WATCHMAN - ADAM HITS THE INTERVIEWER 1 with his heel on the tibia and leans over.

Situation time: about 3 s

SCENE 14 (S14)

THE TRAINED WATCHMAN does not react. TRAINED GUARD 1 stabs the KNIGHT into the back of TRAINED GUARD ADAM and covers himself with his body. END OF EXERCISE.

Situation time: about 4 s

OPTION 4

SCENE 15 (S15)

TRAINED WATCHMAN takes no action, gives no orders. TRAINED GUARD 1 removes documents from his pants pocket and hands them to the BORDER GUARD - ADAM.

Situation time: about 4 s

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SCENE 16 (S16)

BORDER GUARD - ADAM reaches out for a document and is overpowered. TRAINED GUARD 1 positions himself behind the officer's back and puts a knife to his throat. He then shouts that he will kill the officer if the TRAINED WATCHMAN does not put his weapon on the ground and move away.

Situation time: about 30 s

SCENE 17 (S17)

BORDER WATCHMAN - ADAM HITS THE INTERVIEWER 1 with his heel on the tibia and leans over.

Situation time: about 3 s

SCENE 18 (S18)

TRAINED WATCHMAN shoots and misses. TRAINED GUARD 1 thrusts his KNIFE into the back of TRAINED GUARD ADAM and covers himself with his body. END OF EXERCISE.

Situation time: about 4 s

,SCENARIO 1.1

LIST OF SCENES UNDER. IMPLEMENTATION SCENARIO "Illegal crossing of the pasture border in a forested area".

LP.	CODE FROM THE SCRIPT	BRIEF DESCRIPTION OF THE SCENE
1	S1	PREMISES cross the border
2	S2	Officers are approaching the PREMISES
3	S3	CHAIRMAN 1 reaches into his pants pocket.
		OPTION 1
4	S4	EXERCISE gives firm commands.
5	S5	BORDER WATCHMAN - ADAM gives orders.
		OPTION 2
6	S6	THE EXERCISE takes a shot in the direction of PRESIDENT 1.
7	S7	EXERCISE does not take action.

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8	S8	BORDER GUARD - ADAM is overpowered.
9	S9	BORDER WATCHMAN - ADAM strikes back at PREMIERE 1.
10	S10	The EXERCISE takes a shot in the direction of CHAMPION 1, hits.
11	S11	EXERCISE does not take action.

OPTION 3

12	S12	BORDER GUARD - ADAM is overpowered.
13	S13	BORDER WATCHMAN - ADAM strikes back at PREMIERE 1.
14	S14	EXERCISE does not respond.

OPTION 4

15	S15	EXERCISE does not take action.
16	S16	BORDER GUARD - ADAM is overpowered.
17	S17	BORDER WATCHMAN - ADAM strikes back at PREMIERE 1.
18	S18	THE EXERCISE takes a shot in the direction of CHAMPION 1 and misses.

SCENARIO 1.2.

test film script

BRIEF DESCRIPTION OF THE SITUATION:

Illegal crossing of the pasture boundary in a forested area.

TIME:

Dusk/dawn (haze, visibility limited).

LOCATION:

Forest, a firebreak about 200 m in size near the forest road.

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POSTINGS:

- MALE - PRESIDENT No. 1 - A man who looks dangerous (a hoodlum, a "neck"). Age about 35, massive but not powerful, wearing jeans and a sweatshirt, nothing very distinctive. He may have tattoos.
- MALE SMUGGLER DRIVER. A man who looks standard. Age about 45, dressed in cloth pants shirt and sweater, nothing very distinctive.
- MALE OCCASIONALIST No. 1 Asian, Arab or resident of the former USSR, of small stature. Age about 25, dressed in cloth pants shirt and sweater.
- MALE OCCASIONALIST No. 2 - Asian, Arab or resident of the former USSR, of small stature. Age about 50, dressed in pants and shirt.
- MALE OCCASIONALIST #3 Asian, Arab or resident of the former USSR, of small stature. Age about 15 years, dressed in pants and sweatshirt.

EQUIPMENT:

VEHICLE - Bus of any brand, used, built-in cargo section (without windows).

NUMBER OF OFFICERS:

BORDER GUARD - TRAINED - Not visible on the screen (CAMERA is the point of view of the guard).

BORDER WATCHMAN - ADAM - Standard duty equipment + flashlight.

WEAPON USED (ON SCREEN):

- KNIGHT - bayonet, length about 20 cm

SCENE 1 (S1)

From a distance of about 200 meters, the trainee observes 5 people illegally crossing the border. He moves towards them together with a fellow patrolman. At this time, 2 men help the three OBCRATIANS enter the cargo section of a bus parked on a forest road. THE DRIVER'S CHAIRMAN approaches the vehicle door from the driver's side but does not get into the vehicle. CHAIRMAN 1 closes the rear door of the car. At this point, the officers proceed to take action.

Situation time: about 20-25 s

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SCENE 2 (S2)

TRAINED FUNCTIONER (CAMERA) comes closer. He is 5 steps ahead of the situation.

Situation time: about 5 s

SCENE 3 (S3) (Scenes S1, S2, S3 shot in one take)

SPEAKER 1 says, "What do you want? Documents? Coming right up." He reaches into his back pocket at this point.

Situation time: about 3 s

REACTION OF THE GUARD AT THE TRAINING

OPTION 1

SCENE 4 (S4)

THE TRAINED GUARD in a firm voice issues the commands HANDS OFF, LOWER DOWN, HANDS ON PLEASURES, directing the weapon towards GUARD 1, who obeys the commands.

Situation time: about 8 s

SCENE 5 (S5)

At this time, the BORDER GUARD - ADAM points his gun at the DRIVER'S CHAIRMAN, issuing in a firm voice the command to slowly exit the vehicle, lie down on the ground with his hands on his back. The DRIVER'S CHAIRMAN obeys the command. END OF EXERCISE.

Situation time: about 8 s

OPTION 2

SCENE 6 (S6)

TRAINED WATCHMAN fires a shot in the direction of CHAIRMAN 1. CHAIRMAN 1 falls to the ground. THE TRAINED RANGER falls to the ground. END OF EXERCISE .

Situation time: about 3 s

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SCENE 7 (S7)

TRAINED WATCHMAN takes no action, gives no orders. TRAINED GUARD 1 removes documents from his pants pocket and hands them to the BORDER GUARD - ADAM.

Situation time: about 4 s

SCENE 8 (S8)

BORDER GUARD - ADAM reaches out for a document and is overpowered. TRAINED GUARD 1 positions himself behind the officer's back and puts a knife to his throat. He then shouts that he will kill the officer if the TRAINED WATCHMAN does not put his weapon on the ground and move away.

Situation time: about 30 s

SCENE 9 (S9)

BORDER WATCHMAN - ADAM HITS THE INTERVIEWER 1 with his heel on the tibia and leans over.

Situation time: about 2 s

SCENE 10 (S10)

TRAINED WATCHMAN fires a shot in the direction of CHAIRMAN 1, hits. CHAIRMAN 1 falls to the ground. THE TRAINED RANGER falls to the ground. END OF EXERCISE.

Situation time: about 10 s

OPTION 3

SCENE 11 (S11)

TRAINED WATCHMAN takes no action, gives no orders. TRAINED GUARD 1 removes documents from his pants pocket and hands them to the BORDER GUARD - ADAM.

Situation time: about 4 s

SCENE 12 (S12)

BORDER GUARD - ADAM reaches out for a document and is overpowered. TRAINED GUARD 1 positions himself behind the officer's back and puts a knife to his throat. He then shouts

that he will kill the officer if the TRAINED WATCHMAN does not put his weapon on the ground and move away.

Situation time: about 30 s

SCENE 13 (S13)

BORDER WATCHMAN - ADAM HITS THE INTERVIEWER 1 with his heel on the tibia and leans over.

Situation time: about 3 s

SCENE 14 (S14)

THE TRAINED WATCHMAN does not react. TRAINED GUARD 1 stabs the KNIFE into the back of TRAINED GUARD ADAM and covers himself with his body. END OF EXERCISE.

Situation time: about 4 s

OPTION 4

SCENE 15 (S15)

TRAINED WATCHMAN takes no action, gives no orders. TRAINED GUARD 1 removes documents from his pants pocket and hands them to the BORDER GUARD - ADAM.

Situation time: about 4 s

SCENE 16 (S16)

BORDER GUARD - ADAM reaches out for a document and is overpowered. TRAINED GUARD 1 positions himself behind the officer's back and puts a knife to his throat. He then shouts that he will kill the officer if the TRAINED WATCHMAN does not put his weapon on the ground and move away.

Situation time: about 30 s

SCENE 17 (S17)

BORDER WATCHMAN - ADAM HITS THE INTERVIEWER 1 with his heel on the tibia and leans over.

Situation time: about 3 s

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SCENE 18 (S18)

TRAINED WATCHMAN shoots and misses. TRAINED GUARD 1 thrusts his KNIFE into the back of TRAINED GUARD ADAM and covers himself with his body. END OF EXERCISE.

Situation time: about 4 s

SCENARIO 1.2

LIST OF SCENES UNDER. IMPLEMENTATION SCENARIO "Illegal crossing of the pasture border in a forested area".

LP.	CODE FROM THE SCRIPT	BRIEF DESCRIPTION OF THE SCENE
1	S1	PREMISES cross the border
2	S2	Officers are approaching the PREMISES
3	S3	CHAIRMAN 1 reaches into his pants pocket.
		OPTION 1
4	S4	EXERCISE gives firm commands.
5	S5	BORDER WATCHMAN - ADAM gives orders.
		OPTION 2
6	S6	THE EXERCISE takes a shot in the direction of PRESIDENT 1.
7	S7	EXERCISE does not take action.
8	S8	BORDER GUARD - ADAM is overpowered.
9	S9	BORDER WATCHMAN - ADAM strikes back at PREMIERE 1.
10	S10	The EXERCISE takes a shot in the direction of CHAMPION 1, hits.
11	S11	EXERCISE does not take action.
		OPTION 3
12	S12	BORDER GUARD - ADAM is overpowered.
13	S13	BORDER WATCHMAN - ADAM strikes back at PREMIERE 1.
14	S14	EXERCISE does not respond.

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OPTION 4

15	S15	EXERCISE does not take action.
16	S16	BORDER GUARD - ADAM is overpowered.
17	S17	BORDER WATCHMAN - ADAM strikes back at PREMIERE 1.
18	S18	THE EXERCISE takes a shot in the direction of CHAMPION 1 and misses.

SCENARIO 1.3.

test film script

BRIEF DESCRIPTION OF THE SITUATION:

Illegal crossing of the pasture boundary in a forested area.

TIME:

Day (snow/rain, visibility limited).

LOCATION:

Forest, a firebreak about 200 m in size near the forest road.

POSTINGS:

- MALE - PRESIDENT No. 1 - A man who looks dangerous (a hoodlum, a "neck"). Age about 35, massive but not powerful, wearing jeans, sweatshirt and jacket, nothing very distinctive. He may have tattoos.
- MALE SMUGGLER DRIVER. A man with a standard appearance. Age about 45, dressed in cloth pants shirt, sweater and jacket, nothing very distinctive.
- MALE OCCASIONALIST No. 1 Asian, Arab or resident of the former USSR, of small stature. Age about 25, dressed in cloth pants shirt, sweater and jacket.
- MALE OCCASIONALIST No. 2 - Asian, Arab or resident of the former USSR, of small stature. Age about 50, wearing pants, shirt and jacket.
- MALE OCCASIONALIST No. 3 Asian, Arab or resident of the former USSR, of small stature. Age about 15, wearing pants, sweatshirt and jacket.

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EQUIPMENT:

VEHICLE - Bus of any brand, used, built-in cargo section (without windows).

NUMBER OF OFFICERS:

BORDER GUARD - TRAINED - Not visible on the screen (CAMERA is the point of view of the guard).

BORDER WATCHMAN - ADAM - Standard duty equipment.

WEAPON USED (ON SCREEN):

- KNIGHT - bayonet, length about 20 cm

SCENE 1 (S1)

From a distance of about 200 meters, the trainee observes 5 people illegally crossing the border. He moves towards them together with a fellow patrolman. At this time, 2 men help the three OBCRATIANS enter the cargo section of a bus parked on a forest road. THE DRIVER'S CHAIRMAN approaches the vehicle door from the driver's side but does not get into the vehicle. CHAIRMAN 1 closes the rear door of the car. At this point, the officers proceed to take action.

Situation time: about 20-25 s

SCENE 2 (S2)

TRAINED FUNCTIONER (CAMERA) comes closer. He is 5 steps ahead of the situation.

Situation time: about 5 s

SCENE 3 (S3) (Scenes S1, S2, S3 shot in one take)

SPEAKER 1 says, "What do you want? Documents? Coming right up." He reaches into his back pocket at this point.

Situation time: about 3 s

REACTION OF THE GUARD AT THE TRAINING

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OPTION 1

SCENE 4 (S4)

THE TRAINED GUARD in a firm voice issues the commands HANDS OFF, LOWER DOWN, HANDS ON PLEASURES, directing the weapon towards GUARD 1, who obeys the commands.

Situation time: about 8 s

SCENE 5 (S5)

At this time, the BORDER GUARD - ADAM points his gun at the DRIVER'S CHAIRMAN, issuing in a firm voice the command to slowly exit the vehicle, lie down on the ground with his hands on his back. The DRIVER'S CHAIRMAN obeys the command. END OF EXERCISE.

Situation time: about 8 s

OPTION 2

SCENE 6 (S6)

TRAINED WATCHMAN fires a shot in the direction of CHAIRMAN 1. CHAIRMAN 1 falls to the ground. THE TRAINED RANGER falls to the ground. END OF EXERCISE .

Situation time: about 3 s

SCENE 7 (S7)

TRAINED WATCHMAN takes no action, gives no orders. TRAINED GUARD 1 removes documents from his pants pocket and hands them to the BORDER GUARD - ADAM.

Situation time: about 4 s

SCENE 8 (S8)

BORDER GUARD - ADAM reaches out for a document and is overpowered. TRAINED GUARD 1 positions himself behind the officer's back and puts a knife to his throat. He then shouts that he will kill the officer if the TRAINED WATCHMAN does not put his weapon on the ground and move away.

Situation time: about 30 s

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SCENE 9 (S9)

BORDER WATCHMAN - ADAM HITS THE INTERVIEWER 1 with his heel on the tibia and leans over.

Situation time: about 2 s

SCENE 10 (S10)

TRAINED WATCHMAN fires a shot in the direction of CHAIRMAN 1, hits. CHAIRMAN 1 falls to the ground. THE TRAINED RANGER falls to the ground. END OF EXERCISE.

Situation time: about 10 s

OPTION 3

SCENE 11 (S11)

TRAINED WATCHMAN takes no action, gives no orders. TRAINED GUARD 1 removes documents from his pants pocket and hands them to the BORDER GUARD - ADAM.

Situation time: about 4 s

SCENE 12 (S12)

BORDER GUARD - ADAM reaches out for a document and is overpowered. TRAINED GUARD 1 positions himself behind the officer's back and puts a knife to his throat. He then shouts that he will kill the officer if the TRAINED WATCHMAN does not put his weapon on the ground and move away.

Situation time: about 30 s

SCENE 13 (S13)

BORDER WATCHMAN - ADAM HITS THE INTERVIEWER 1 with his heel on the tibia and leans over.

Situation time: about 3 s

SCENE 14 (S14)

THE TRAINED WATCHMAN does not react. TRAINED GUARD 1 stabs the KNIFE into the back of TRAINED GUARD ADAM and covers himself with his body. END OF EXERCISE.

Situation time: about 4 s

OPTION 4

SCENE 15 (S15)

TRAINED WATCHMAN takes no action, gives no orders. TRAINED GUARD 1 removes documents from his pants pocket and hands them to the BORDER GUARD - ADAM.

Situation time: about 4 s

SCENE 16 (S16)

BORDER GUARD - ADAM reaches out for a document and is overpowered. TRAINED GUARD 1 positions himself behind the officer's back and puts a knife to his throat. He then shouts that he will kill the officer if the TRAINED WATCHMAN does not put his weapon on the ground and move away.

Situation time: about 30 s

SCENE 17 (S17)

BORDER WATCHMAN - ADAM HITS THE INTERVIEWER 1 with his heel on the tibia and leans over.

Situation time: about 3 s

SCENE 18 (S18)

TRAINED WATCHMAN shoots and misses. TRAINED GUARD 1 thrusts his KNIFE into the back of TRAINED GUARD ADAM and covers himself with his body. END OF EXERCISE.

Situation time: about 4 s

SCENARIO 1.3

LIST OF SCENES UNDER. IMPLEMENTATION SCENARIO "Illegal crossing of the pasture border in a forested area".

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LP.	CODE FROM THE SCRIPT	BRIEF DESCRIPTION OF THE SCENE
1	S1	PREMISES cross the border
2	S2	Officers are approaching the PREMISES
3	S3	CHAIRMAN 1 reaches into his pants pocket.
		OPTION 1
4	S4	EXERCISE gives firm commands.
5	S5	BORDER WATCHMAN - ADAM gives orders.
		OPTION 2
6	S6	THE EXERCISE takes a shot in the direction of PRESIDENT 1.
7	S7	EXERCISE does not take action.
8	S8	BORDER GUARD - ADAM is overpowered.
9	S9	BORDER WATCHMAN - ADAM strikes back at PREMIERE 1.
10	S10	The EXERCISE takes a shot in the direction of CHAMPION 1, hits.
11	S11	EXERCISE does not take action.
		OPTION 3
12	S12	BORDER GUARD - ADAM is overpowered.
13	S13	BORDER WATCHMAN - ADAM strikes back at PREMIERE 1.
14	S14	EXERCISE does not respond.
		OPTION 4
15	S15	EXERCISE does not take action.
16	S16	BORDER GUARD - ADAM is overpowered.
17	S17	BORDER WATCHMAN - ADAM strikes back at PREMIERE 1.
18	S18	THE EXERCISE takes a shot in the direction of CHAMPION 1 and misses.

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