



# European Media and Immersion Lab

## D3.11 – Location Based Experience Demonstrator

### *WP3T4 – Scalable Location Based Experience*

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<b>Abstract</b>
<p>This document describes the background and current status of FABW's Lighthouse Project "MinoXR" (working title), the story, design, interaction mechanics, technical implementation and the public demonstrator of the November 2023 prototype of this scalable interactive multi-user location-based XR experience.</p>

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## 1 Introduction

Within the European Media and Immersion Lab (EMIL), the goal for Filmakademie Baden-Württemberg (FABW) is to create an interactive, scalable, narrative Location Based Experience (LBX) with emphasis on telling a compelling story. Greek mythology is an important part of the European cultural heritage from which we picked the story of the Minotaur as the centre of our endeavour (Figure 1). This LBX is currently named “MinoXR” (working title).

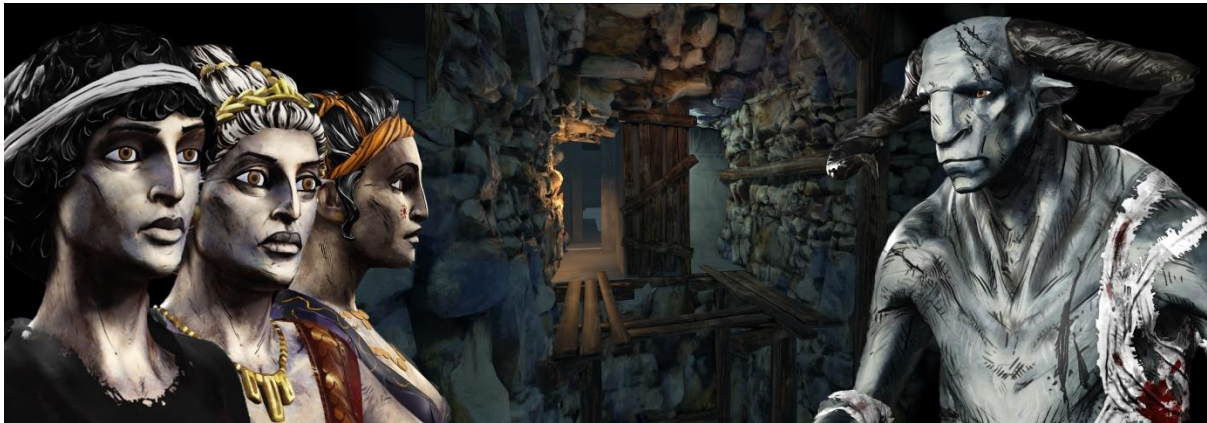


Figure 1 From left to right: the player avatar, Pasiphae, Ariadne and the Minotaur

The players slip into the roles of human sacrifices from Athens, who are sent to the Isle of Crete to be devoured by the Minotaur in the labyrinth. On Crete, they meet Ariadne, the half-sister of the Minotaur. She tries to convince the players to kill the Minotaur, so she can escape with them from the island. Yet, the players also meet Pasiphae, the mother of the Minotaur. She begs for mercy for her son. It's up to the players to decide which side they take.

## 2 Background

The story of the Minotaur's labyrinth offers exciting aspects for an interactive Location Based Experience. For this reason, unsurprisingly, there already are some VR experiences, that make use of this mythological background. But these are usually action-oriented games, whereas MinoXR focuses on the underlying narrative relevance and emotional impact of the original myth.

### 2.1 Target Audience

Our goal is to engage general audiences into an adventurous story-world and make them relate to it emotionally, no matter whether they do not already know about Greek mythology or are experts in the field.

At the current moment, Virtual Reality, especially VR in our understanding of it as being interactive, is still a unique and new experience for general audiences. The rules on how stories are told in VR, especially interactive ones, are not yet established, which makes it exciting for storytellers and



audiences alike. In a theatre, people know they are expected to sit still, watch and listen for the best experience. In games, they might know how to use a joystick or gamepad. But in VR, they may not yet know how to use the controller and if they are expected to stand still and listen (lean backward mode, as in traditional camp-fire storytelling) or react and interact in a specific way (lean forward mode, as in computer games). In contrast to experienced gamers, who know how to use the technology they own, audiences of location based experiences usually don't know anything about the rules of the experience they are about to make and usually they don't want to invest too much time learning or may end up feeling incapable or out of control. Our LBX will be targeted towards this general audience and should make them feel immersed in our story world, instead of causing disorientation or confusion. For that reason, we put our efforts into keeping the narration and game mechanics simple, yet surprising, entertaining and satisfying.

## 2.2 Scalability

The scalability of the experience is a key feature of our LBX with the general idea to provide different versions depending on the users' hardware capabilities and available physical space. Therefore, we are developing the LBX in 3 different scale levels:

1. Single Player seated
2. Single Player in a room-scale environment
3. Free-Roaming Multiplayer

### 2.2.1 Scale Level 1: Single Player seated

The easiest way to access the experience will be a 180° non-interactive stereoscopic video, which is using the same game assets that were already created for the other scale levels. This video only needs a video player and is best consumed via a stereoscopic headset. We can increase the visual quality compared to the interactive scale levels, since it does not need to be real-time rendered on the VR headset. The video will be a direct derivative of the technically more demanding scale levels 2 and 3, which have been the team's focus up until now.

### 2.2.2 Scale Level 2: Single Player in a room-scale environment

Scale Levels 2 and 3 make the player an active character in the game. But scale level 2 requires controller-based player movement, since it is targeted for locations with small spatial resources between 2-4m<sup>2</sup> (e.g. a living room). We picked the simple, established option for moving through the labyrinth by using the thumb-stick of the VR controller. We tested this scale level with special attention to possible motion sickness and were able to avoid it by slowing down some of the movements of the environment (such as for instance the movement speed of elevators and platforms). Scale level 2 is played in standing mode, since it is important that the player can pick up and use objects that lay on



the ground or behind the player. Physically turning instead of turning with the thumb-stick also prevents motion sickness for the user because of an adequate coupling within the visuomotor and kinaesthetic senses of the user.

We may include a multiplayer option in the future, for which the players would not need to share a large physical space as in scale level 3. As a side product we have been building the basis for this alternative multiplayer mode with our development of scale level 3. This mode could be accessed via local or online network and thus be played either co-located or physically remote.

### 2.2.3 Scale Level 3: Free-roaming Multiplayer

Moving around physically with your friends in a VR experience provides an extra amount of immersion and fun, only achievable in location based entertainment. Therefore, this third scale level targets locations with a dedicated physical play area of at least 8 x 8 m (Figure 2). A bigger space would have given players more room to walk around, but not many locations can provide larger play areas, thus making the experience less attractive for possible vendors. Since players share the same physical space while interacting, redirected walking cannot be achieved. Therefore, we had to creatively fit our active play area into this space. All non-player voice performances are written to equally address single or multiple players of any gender. We limited the number of active players to 4, since otherwise they would block too much of each other's space within the confined play area.



Figure 2 Players testing Scale Level 3 during FSTP Call1 Kick-off in Barcelona, October 2023



## 3 Current status of the “MinoXR” Location Based Experience

In the current status, the story and game-play of our LBX are complete for scale level 2 and 3. We recorded all necessary motion capture and voice performances for the experience and implemented them together with all game mechanics. All currently available game assets are in a state that allows play-testing of the experience, with some assets still missing textures. The overall sound design is a layout. The most important musical cues have been produced, others will follow in the coming months.

### 3.1 Story

Players start the experience in an empty void, containing only a wooden pier and an instruction text. They are invited to calibrate their body size on the pier, after which the ship that will transport the players to Crete appears at the end of the pier. To initiate the experience/narrative, once everybody is on board the ship, the players can turn the steering wheel of the ship. At the beginning of the story, the players are welcomed in the harbour of Knossos by King Minos, his wife Pasiphae, and his daughter Ariadne. Minos explains to the players that they are about to enter the labyrinth, which was built by his craftsman Daedalus. In the labyrinth, they will become the “treat for the Minotaur” - the creature that the gods created to punish him and his beloved wife. Ariadne seems to care for Pasiphae, who appears to be uncomfortable with the situation.

The players enter the labyrinth via an elevator. Depending on which path they take, they either meet Ariadne or Pasiphae as a guiding character - or both if the players split up. The women’s voices explain the back story of the Minotaur via murals on the walls on two dividing paths through the labyrinth. Ariadne portrays the Minotaur as a monster while Pasiphae explains her unconditional love for the poor creature, trying to evoke empathy in the players.

On a balcony, the players gather to solve a puzzle with Ariadne giving important advice on how to solve it. As soon as the players push the correct buttons, the balcony reveals itself as one of Daedalus’ intricate inventions and starts to move via a huge mechanical wooden construction giving the players access to another hidden path. Several cogwheels need to be found to open doors in the following section of the labyrinth and the players have to show courage when walking over an abyss on some wooden planks to turn a mechanic dial and open up a passage to a new chamber. Here they are confronted with the skeletal remains of other human sacrifices that came before them and obviously died there due to a broken mechanism. One of them is still holding a sword which can be picked up and will become helpful later on, but first they need to repair the mechanism by replacing the lever with one of the scattered bones.

As soon as the players pull the repaired bone-lever, the floor starts to move them upwards into a huge hall. From an opening in the ceiling, Ariadne congratulates them on making it this far. The hall consists of nine moving platforms that players need to step on in the correct pattern to be elevated up to Ariadne. But before they arrive at the top, the platforms stop, and Ariadne needs to take action. She searches



for a lever that may elevate the players to the top and the labyrinth's exit, but picks the wrong lever, opening a gate through which the Minotaur enters! He is already covered in bandages and seemingly in bad physical shape, showing wounds and limping. He starts attacking the players and crashes into walls. Ariadne proposes to break some of the scattered bones and to use them to stab the Minotaur. After a short fight, the injured Minotaur breaks down and sends out a cry, calling for Pasiphae to enter the hall. She again begs for mercy for her son, while Ariadne is still eager to get the players to kill her half-brother. The players may now choose which way they want the narrative to progress: If they drop their weapons and gather in the middle of the room, Pasiphae grants freedom to the players and they can sail away with Pasiphae waving goodbye from outside the coast, promising to no longer mistreat the honourable people of Athens. If they decide to kill the Minotaur, Pasiphae bursts into tears and they can leave the island with Ariadne, who now shows some signs of doubt about the outcome of the taken actions.

### **3.1.1 Interpretation**

Since our goal was to create a narrative LBX, we focused on storytelling and combined it with elements of puzzle and action for interactivity. We explore the underlying universal topic of guilt and shame and give it a fresh narrative take. We don't simply display the creature (the Minotaur) as a raging monster. He can be seen as a troubled soul, who deserves empathy for his fate. It is King Minos, who forces death upon the human sacrifices. Furthermore, we go deeper and reveal Pasiphae's unconditional love for her son.

In the classic tale, Ariadne is falling in love with Theseus, who mingled with the human sacrifices in order to kill the Minotaur. In our LBX, we wanted to avoid having any of the players stand out as Theseus and having Ariadne fall in love with one particular player. Therefore, in our interpretation, Ariadne needs the players to kill her half-brother, so she can escape with them from the island. We also de-construct the classical role of Theseus as "the mighty male hero". In our LBX, any player, no matter what gender, is free to kill the Minotaur, even though this action is no longer presented as a heroic act.

## **3.2 Design**

### **3.2.1 History**

The story of the Minotaur and the labyrinth is an ancient popular myth. As we didn't want to create a made up fantasy setting, we researched the historical origins of the tale for our project. The most probable background for the myth is the palace of Knossos on the Greek island of Crete where the Minoans resided 3100 – 1100 BC. The Minoan culture goes back to King Minos, the antagonist of our story. Here we start to wander between myth and real history, as Minos famously had the labyrinth built by the master builder and technician Daedalus. Daedalus is a mythical legend himself, mostly





because of his tale with his son Icarus. Since there are no historical references to these larger-than-life legends, this opened up the space for us to creatively fill in the gaps.

### 3.2.2 Visual Concept

Due to the historical background and the technical limitations for mobile VR-devices, we chose a stylized look for the experience, based in part of the clay aesthetics of ancient Greek pottery. Not necessarily a disadvantage, as it fits in well with the look of the Minoan illustrations from, for instance, reliefs and vases we want to mimic.

### 3.2.3 The Characters

The character design is based on these illustrations on murals and vases from the Aegean Bronze Age. The clothes and their patterns are very close to the style of the Minoan culture of the time. But because the fashion of the time, especially for women of higher rank who may have been exposing their breasts, could have been very liberal by today's standards, we took liberties and adapted it to suit both worlds by covering the nudity while keeping the style (Figure 3-11).<sup>1</sup> For the player avatars, the character design was conceived in such a way as to allow for users of all genders to identify with the avatar by designing it in an androgynous form that cannot be assigned clear gender attributes (Figure 12). In the upcoming production process, these player avatars will be individualized by colour of e.g. headband, wristband, belt.

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<sup>1</sup> See for example: Lee, M. M. (2000). Deciphering Gender in Minoan Dress. In A. E. Rautman (Ed.), *Reading the Body: Representations and Remains in the Archaeological Record* (pp. 111–123). University of Pennsylvania Press. <http://www.jstor.org/stable/j.ctv512z16.13>



Figure 3 A Cretan snake goddess from the Minoan civilization, c. 1600 BC, Figures from the Agia Triada Sarcophagus<sup>2</sup>



Figure 4 The Royal Family: King Minos, Ariadne, Pasiphae and the Minotaur

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<sup>2</sup><https://t.ly/qPDLO>  
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Figure 5 2D Concepts of Ariadne



Figure 6 Ariadne (daughter of Pasiphae and sister of the Minotaur)



Figure 7 2D Concepts of Minos (King of Crete and the Antagonist who send the Players into the Labyrinth)



Figure 8 3D Model of King Minos

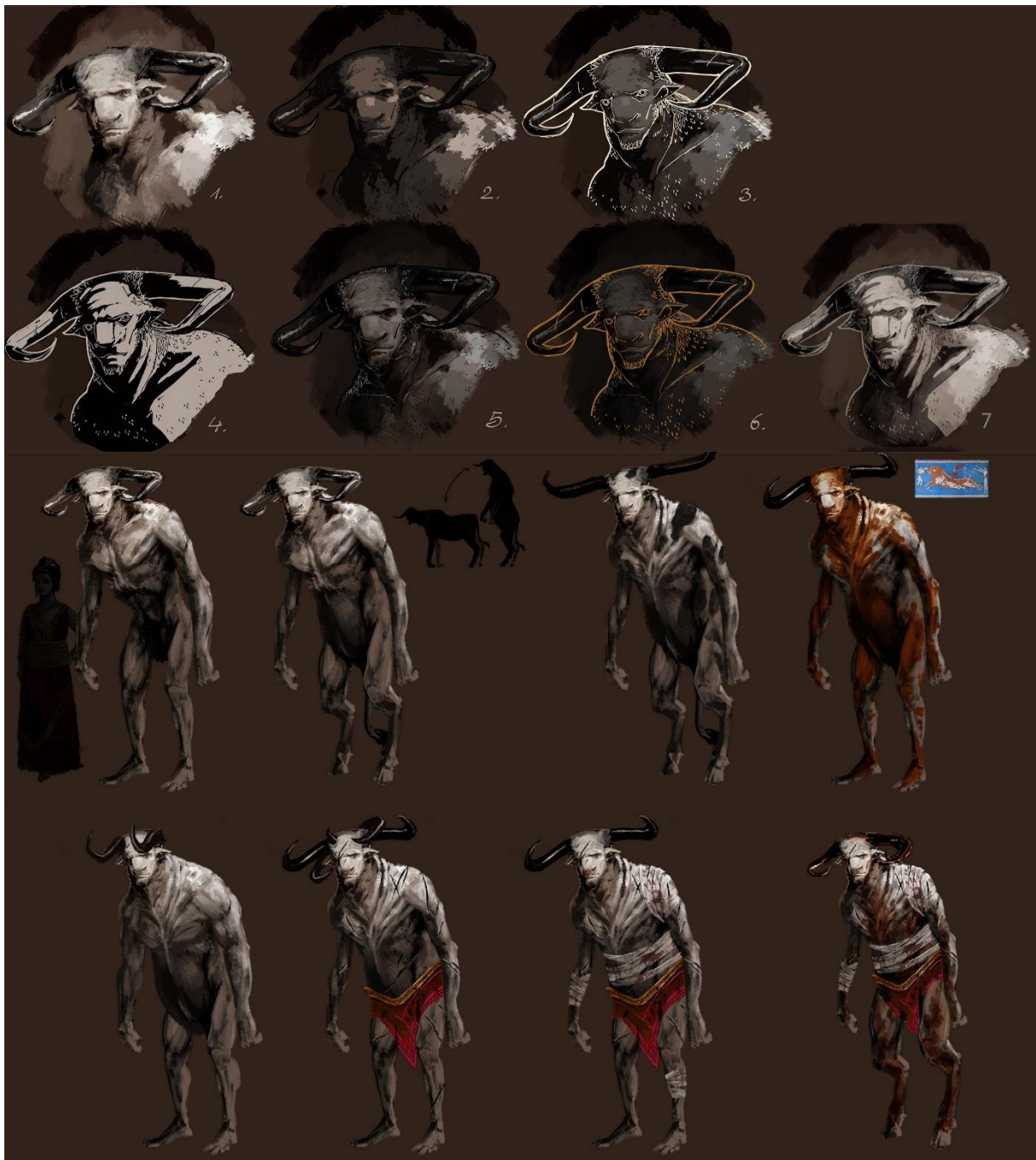


Figure 9-10 2D Concepts of the Minotaur (The foe or the victim of the story?)



Figure 11 Final Design of the Minotaur



Figure 12 Avatar (Visual appearance of the Player)



### 3.2.4 The Environment

The design language of the surroundings is largely based on the excavations of the palace of Knossos by Arthur Evans.<sup>3</sup> The palace is a rich collection of ornaments and forms and a pool from which we were able to draw visually in many ways (Figure 13). The architecture of the palace itself is so labyrinthine that it seems likely that people used to perceive it as the labyrinth we know from legend.

The initial part of the experience involves entering the labyrinth, and to complement our unique style, we designed a custom lighting set-up to create a more dramatic atmosphere. The use of hard, dark shadows helps accentuate the sensation of being lost in the compact 8 by 8-meter space, encouraging players to navigate the maze with caution (Figures 14-15).



Figure 13 2D Concept for Minos palace

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<sup>3</sup> see e.g. [https://ia800708.us.archive.org/view\\_archive.php?archive=/22/items/crossref-pre-1909-scholarly-works/10.1017%252Fs0068245400000745.zip&file=10.1017%252Fs0068245400001404.pdf](https://ia800708.us.archive.org/view_archive.php?archive=/22/items/crossref-pre-1909-scholarly-works/10.1017%252Fs0068245400000745.zip&file=10.1017%252Fs0068245400001404.pdf)



Figure 14 2D Concept of the interior labyrinth



Figure 15 2D Concept of the final encounter

### 3.3 Interaction Mechanics

After the onboarding level described in chapter 3.1, players arrive at the island of Crete on a ship outside the Minoan castle. This level introduces the users to the narrative arc but involves no interaction mechanics. These begin with the descent into the labyrinth.





### 3.3.1 Labyrinth Level

At the entrance, players encounter two torches that they can grab with their controller and that - by lighting the until then dark corridors - allow them to split up and explore two different paths. These paths lead them to either Ariadne or Pasiphae, who provide their unique perspectives on the Minotaur. Additionally, players can come across murals within the labyrinth, offering insights into the back story of the beast.

The experience is designed to have both global events and local events. A global event, for instance, occurs when a player triggers characters like Ariadne or Pasiphae in this Labyrinth Level. In this case, the animated characters act simultaneously in all clients, encouraging players to communicate if they have split up and are receiving different information from these characters on different paths.

On the other hand, local events are only experienced by the player triggering them. Examples of this are the murals, which provide the background story individually to each player and are played by individual player's triggering them.

As the group of players reaches a balcony, Ariadne emerges behind a wall, communicating with the group through a hatch. The room features a puzzle with sculpted bull heads on the walls, some of which are coloured white, with the number of white bull heads varying depending on the number of players. To activate the transition mechanism, players must locate and simultaneously press all of these white bull heads.



Figure 16 Two bull head buttons on the balcony

These bull heads function as large buttons and are connected to the *GameManager*, monitoring the states of all relevant buttons upon every press. The transition event initiates when the count of



pressed buttons is double the number of players, propelling the players into the next part of the labyrinth.

### 3.3.2 Stone Wheel Level

In the next part of the experience, players arrive in a small space where their path is blocked by a massive stone wheel - posing the next puzzle mechanic in the experience. Players can discover a wooden construction resembling a wheel. Rotating this construction over a certain number of degrees triggers an event to set the mechanism in motion.

From a technical perspective, the stone wheel is animated and moves as part of a sequence, stopping at the next point until another similar construction is found and rotated. This event repeats a third time and opens the way to a chamber, which may appear to be a dead end initially.



Figure 17 The stone wheel door blocking the players' path

In this chamber, players encounter a broken lever mechanism. By picking up and placing an object into the lever slot, such as a bone that they can find in the chamber, the object is deactivated and then reactivated as a functional lever within the mechanism. Once the lever is pulled over a specific number of degrees, it begins to elevate the group to the next section.

### 3.3.3 Platforms Level

As the next puzzle, the group enters a room with a grid of 3x3 platforms, where two platforms are already elevated higher than the others, suggesting the possibility of movement. Upon looking up, they spot a door in the wall. Ariadne appears and hints that the platforms are moveable.



Figure 18 The platforms leading up to the Minotaur encounter in different height states

Each platform is registered in a list managed by a *PlatformManager* and has an active state and an invisible trigger box. When the first player enters a trigger box, they initiate a mechanism that sets all platforms to an inactive state to prevent random triggering and plays an animation sequence on the player who activated the mechanism. Our network implementation synchronizes the movement of platforms across all clients (Figure 19).

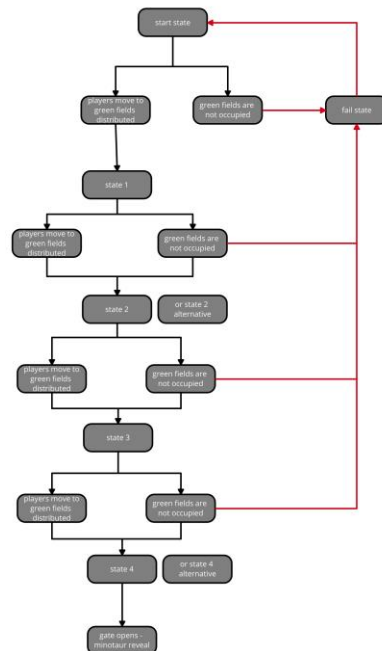
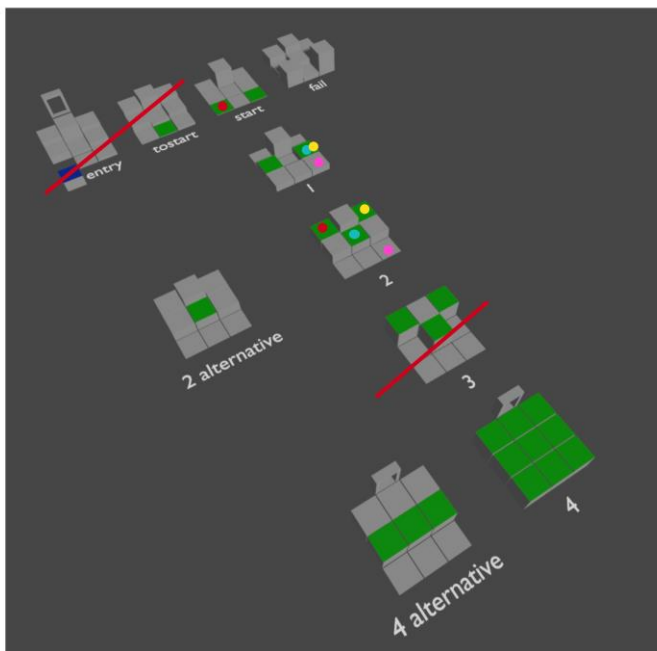


Figure 19 Work in progress version of the platform level logic



As the platforms reach a specific point in the sequence, an event is emitted, synchronizing the sequence's playtime position on every client and reactivating the platforms for other players to trigger the next state. Simultaneously, when the elevation to this room begins, a countdown starts. If the players fail to reach the final stage before the countdown reaches zero, the next trigger event automatically initiates a procedure that collects all the platforms from the lowest to the highest positions and moves them to the end destination, where the Minotaur event begins. In short, players move independently between the platforms, lowering or raising them until they reach the highest level where they encounter the Minotaur.

### **3.3.4 Minotaur Level**

In the final chapter of our experience, the group must prove themselves in the battle against the Minotaur. After solving the platform puzzle, they encounter the Minotaur at the highest point. Players have the option to craft a dagger by breaking bones lying on the ground or to use a sword.

The Minotaur selects a random player, focuses on the player, and charges towards the player. From a certain distance, the character commits to a direction and continues running straight. This gives the player the opportunity to dodge the attack. If the player manages to evade the Minotaur, the Minotaur will hit the wall and take damage. However, in the current project development phase, the concept is that if the Minotaur hits the player, the screen momentarily blacks out, the camera may potentially shake, with the field of view becoming blurry, causing the player to take damage. After each hit, the enemy needs a brief moment to recover. Players can utilize this time to attack the Minotaur with their weapons.

Once the Minotaur has lost its health points – through its own anger and by hitting the walls or through the players –, it collapses injured, triggering a cutscene. Such cutscenes relate to non-interactive sequences often derived from motion capture data to match a specific movement characteristic. Subsequently, the group can decide whether to strike the final blow or spare the Minotaur's life before its demise.

The game mechanics in the final chapter of our experience posed a challenge with the following question: How can we seamlessly blend cutscenes and gameplay without the player noticing, especially at the end of the battle when the Minotaur collapses and transitions into a cutscene?

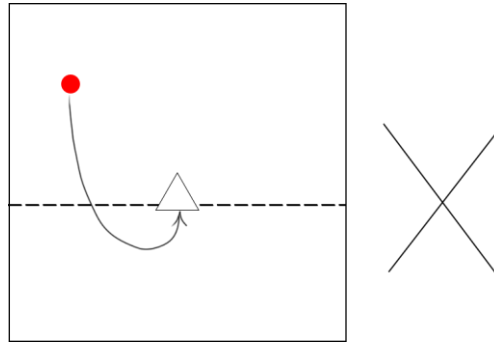


Figure 20 Minotaur - Unusual Turn

To smoothly transition into a cutscene, the requirement is for the enemy to collapse repeatedly in the same spot. If the Minotaur had a fixed position and rotation at which it was supposed to collapse, it might appear odd for it to run to that position and then turn to die (if the Minotaur stands in the wrong position) (Figure 20).

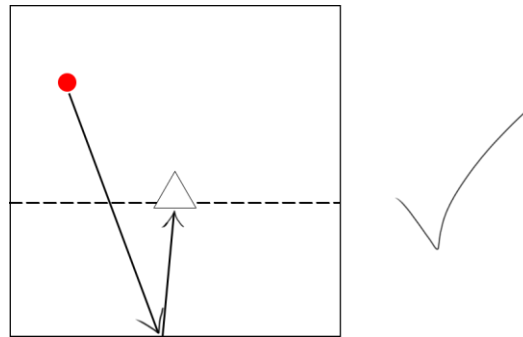


Figure 21 Potential Solution – hitting a wall

Potential solution: a smooth transition could be achieved using an "end move" triggered after a specific duration. The Minotaur runs into a wall (behind the end position), staggers toward its final position, and then collapses (Figure 21). This way, the enemy doesn't need to turn since it does so after running into the wall.

However, as this pattern might become repetitive, the Minotaur reaches its final position as follows (Figure 22):

1. A zone is calculated behind the final position.
2. A probability is calculated for each player being in the final position. If the player stands within the end zone, they receive 100%; if they stand in the direction of the end zone (possibility that they dodge the attack), they get 50%. If none of these apply, they receive 0%.
3. The Minotaur chooses the player with the highest probability and charges at them.
4. If a collision occurs within the end area, it limps to its final position.
5. (Backup) If the players are not in the area within x minutes, the end move (running into the wall in the end zone) is triggered.

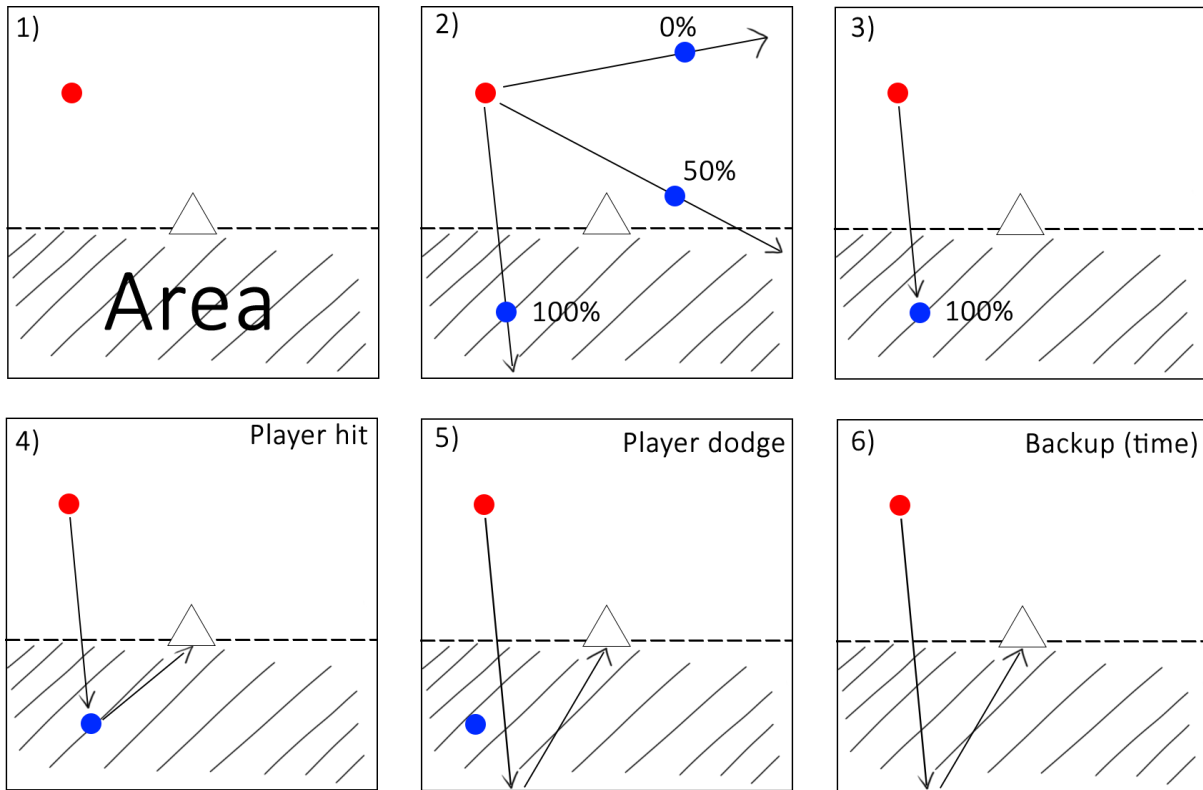


Figure 22 1) Defining the Area, 2) Calculating the probability, 3) Selecting the player with the highest probability, 4) Hitting the player, 5) Player dodges the attack, 6) Backup – using a time

This mechanism ensures that the gameplay varies from game to game, and the battle can seamlessly transition into the cutscene without abrupt cuts.

### 3.4 Technical Implementation

Implementing the features and mechanics for a story-driven free roaming multiplayer experience can be broken down into the following subtopics:

- Player Controls (This includes Full Body Representation, Calibration, Network Replication)
- Game Manager
- Interactive Objects
- Animation

Each of those subtopics is interconnected but will be explained separately for better understanding.

#### 3.4.1 Player Controls

Developing a player character within our experience design constraints required experimental prototyping and player testing. Since we wanted players to perceive themselves as whole characters within the game, we needed to decide on how the player character would appear to them.



As the gameplay involved concepts like fear of heights and stepping onto moving platforms, we opted not to display our digital legs to the player himself. This decision was made because animating the legs would require procedural animation or a state machine, both of which couldn't match the motion to our physical legs. Additionally, a machine learning approach was not feasible due to limitations in processing power on our target devices. This approach would also restrict seated gameplay options. However, as explained below, players do see their co-players full bodies.

For achieving this full-body representation for the co-players, we employed an Inverse Kinematic Control Rig (Figure 23-24). This rig allows the digital skeleton to mimic specific positions and rotations provided by the Head-Mounted Display (HMD) or controllers. With just these three reference points, we can authentically replicate upper body movements. However, for the lower body, such as legs, animation is performed procedurally or through a state machine, which triggers pre-recorded animations based on various inputs, including player height (walking or crouching), velocity (standing or walking), and rotation angle (standing/walking straight or turning).

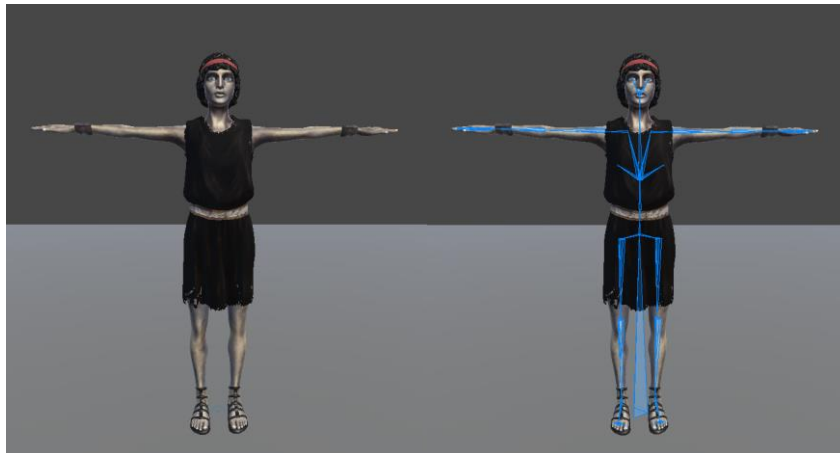


Figure 23 Network Player Character without and with visible Skeleton

While the full-body representation is used exclusively for replicating the characters of other players, we adopted a similar rig for our own player character representation. In this case, only our arms are visible, a deliberate choice aimed at preventing confusion by keeping our physical leg movement separate from the digital representation, which proved to be the most preferred approach during player testing.

Body size calibration was another important topic for the game design. While a Full Body Inverse Kinematic rig provided a good starting point, we faced the challenge of accommodating players with different body heights. The reference height for the rig is typically determined by the artist responsible for the 3D model. In some cases, this could result in an issue where the player's virtual character doesn't match their actual height. For example, when the input device, such as a controller, accurately provides position and rotation in the virtual world, the character's body might be smaller than the player's real body, leading to shorter arms.

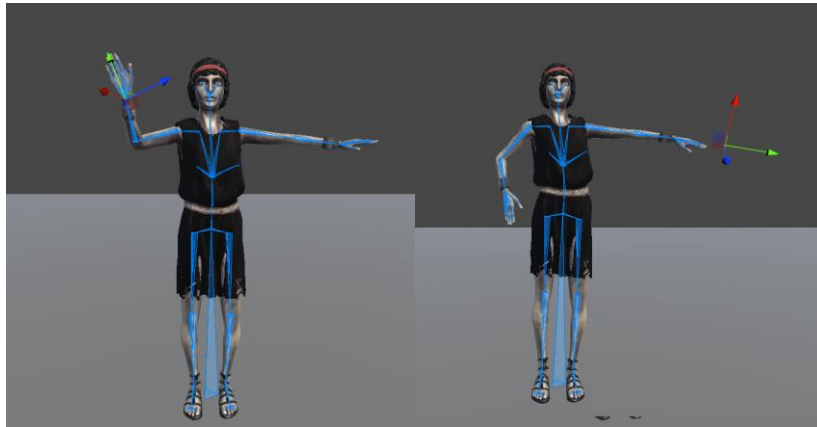


Figure 24 Left: Arm following the right hand IK Target. Right: Target out of Reach

As we planned to allow players to exchange dynamic objects between each other, it was essential to ensure that the visual representation of their hands and the attachment points were as accurate as possible. To achieve this, we implemented a calibration functionality that adjusts each player's estimated body height based on their HMD position. This individual calibration enables us to match every character's height to that of the player, and we distribute these measurements over the network to update all players with the dimensions of the other players.

Multiplayer games rely on network replication logic and an efficient method of keeping all relevant data in sync (Figure 25). Sending every bone in the IK Rig to match the Player and their replicated network counterpart would be too performance-intensive. Instead, we only transmit the transformation data of the HMD and controllers to synchronize both rigs. The positions and rotations of the head and hands are critical, while position and rotation offsets in spine or leg bones, mainly serving aesthetic purposes, can be disregarded.



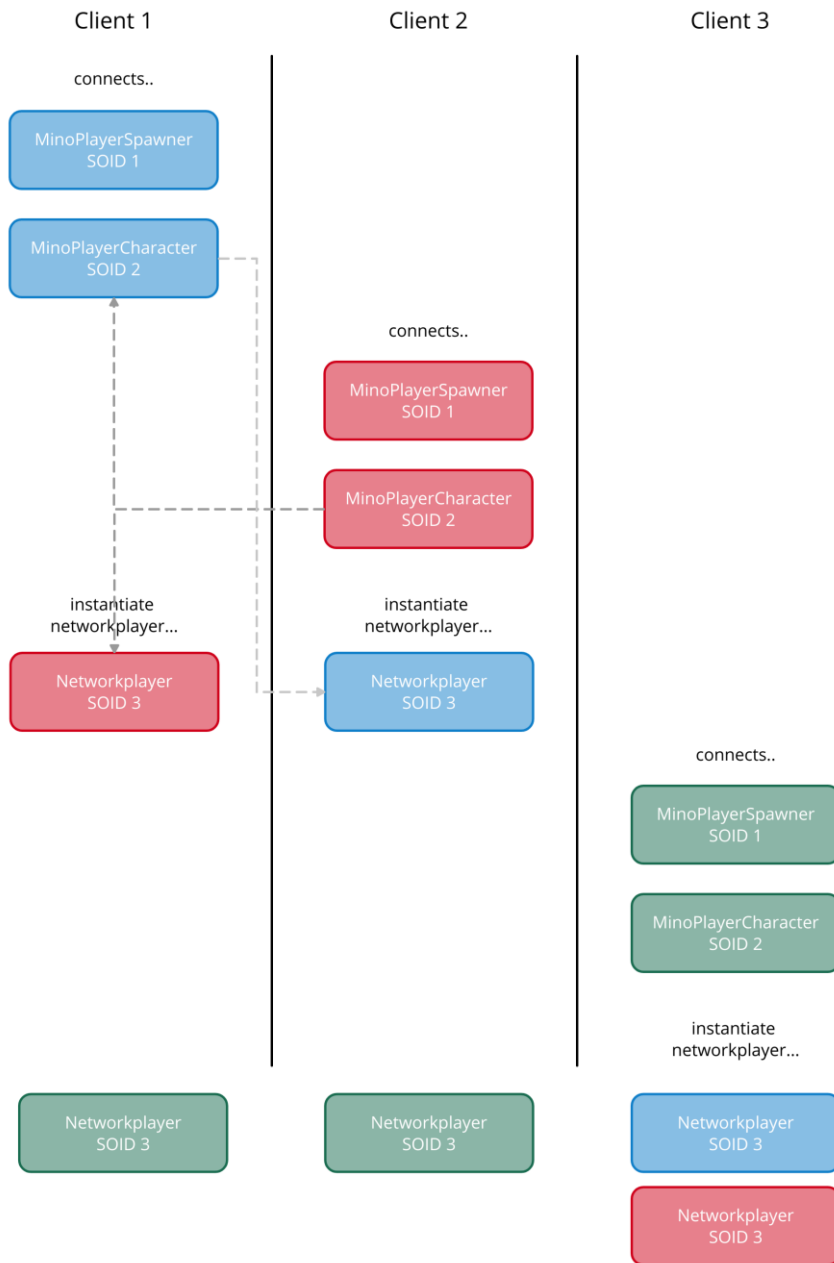


Figure 25 Player replication process for multiple clients

Our network implementation doesn't employ a dedicated server. We use Remote Procedure Calls (RPCs) to facilitate communication between clients. When a new client joins the session, it sends an RPC to check if it's the only client in the session. If not, existing clients respond with their ID, derived from their device's IP address. Each client maintains a list of known players and replicates every known player as a Network Character locally. Using the IP address as the Client ID helps prevent unnecessary duplicates in the event of dropouts and reconnections.



The network client communication is realized using the TRACER FOUNDATION<sup>4</sup> Framework, which has been extended to meet the specific requirements explained above. It features a synchronized, abstract network communication layer providing high level access to the described synchronisation, communication and replication functionalities. The TRACER FOUNDATION was initiated on behalf of Filmakademie R&D funds and is further developed in the scope of the EU funded project MAX-R<sup>5</sup> by Filmakademie and this lighthouse project. The TRACER FOUNDATION is released open-source on Github<sup>6</sup> and is used within the Game via it's own plugin system.

While our network implementation allows us to track and handle objects and it's states individually, the game logic also relies on global events that need to happen synchronously on every connected client. Examples include starting an elevator or triggering the appearance of the Minotaur. To achieve such network triggers, we employ a *GameManager*, which monitors the number of active players and the states of specific events. To prevent a player from being left behind during story transitions, we either wait until the last player enters a specific area or adjust the number of interactive objects when the first person enters the room to match the number of active players. This *GameManager* is present on every client and initiates communication between all instances as soon as any registered event is triggered.

### 3.4.2 Interactive Objects

An illustration of our network implementation can be found in how we handle interactive objects in our project (Figure 26). Each of these objects inherits from a common base class and provides consistent functionality, such as synchronizing their transforms or setting locks.

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<sup>4</sup> <https://animationsinstitut.de/en/research/tools/tracer>

<sup>5</sup> <https://max-r.eu/>, Horizon Europe Project MAX-R (101070072)

<sup>6</sup> <https://github.com/FilmakademieRnd/TRACER>

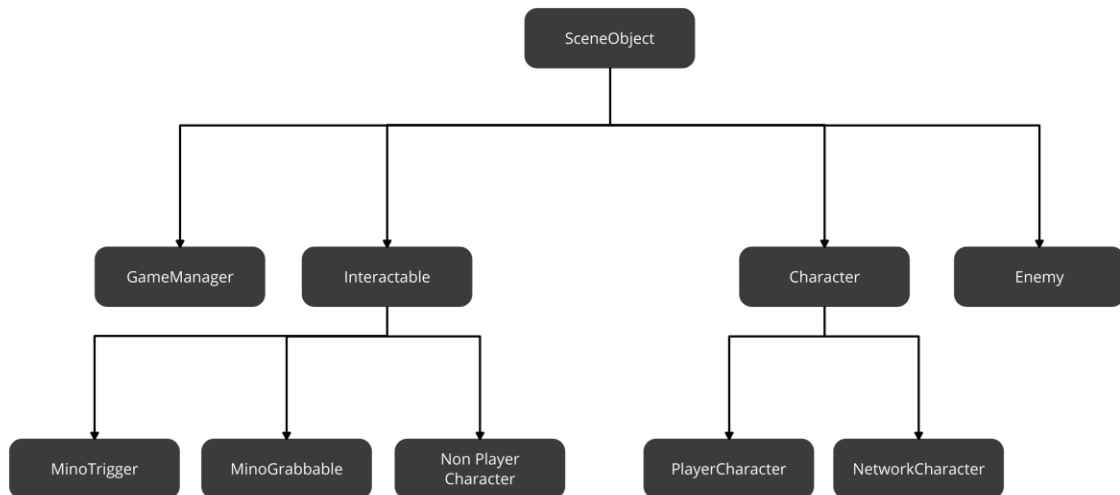


Figure 26 Hierarchic view of interactive Objects.

The capability to set locks is particularly vital, as some of these objects can be picked up and carried by players, and a few even involve physics calculations, like gravity. To ensure uniform physical simulation and correct transformation for all players, the player manipulating the object gains authority over all data changes by locking that specific object. This authority remains in their hands until they lose it to another player. Without this lock feature, objects would behave unpredictably because many players could update the same values simultaneously.

Some of our interactive objects include global triggers that communicate through Remote Procedure Calls (RPCs). These objects are often components of larger puzzle mechanics and can relay their states, such as whether a button is pressed, to the game manager. The game manager then evaluates whether all necessary conditions are met before triggering a global event.

### 3.4.3 Animation

As we developed a story-driven experience that involved both actors and digital characters, we needed a way to animate with a cinematic approach, even though every player acts as their own camera. In our Unity Engine-based project, we utilized the Timeline sequencing tool to set up all story-relevant animations. This choice allowed us to maintain precise synchronization between animation and audio, which was especially important as we employed pre-recorded lip sync animations. Furthermore, the sequencing tool proved to be versatile in its ability to interact with the game world and trigger events. This functionality was highly advantageous for implementing linear mechanics driven by storytelling.

The sequencing tool also provided us with the capability to seamlessly blend its own animations with gameplay animations, which played a crucial role in the final battle. For instance, the Minotaur's



appearance was cinematically staged within a sequence, smoothly transitioning into his game animation state machine for the battle phase, making the encounter fully interactive. After the Minotaur is defeated, the sequence seamlessly leads into another sequence for the grand finale.

## 3.5 Public Demonstrator

### 3.5.1 Filmakademie XR Day on November 29th 2023

Filmakademie organises an annual event in which we invite speakers to give XR input lectures followed by a vivid discussion. The entire event was a mandatory lecture for the 3rd and 4th year students of the degrees Animation, Animation Effects Producing, Interactive Media, and Technical Directing but also accessible publicly. Individuals interested in the MinoXR Demonstrator must schedule a time slot via the publicly available LinkedIn event<sup>7</sup>. This event was promoted on several channels, such as Filmakademie's and Animationsinstitut's Instagram and LinkedIn channels as well as the EMIL social media channels and website and by inviting professionals directly. The input lectures for this years' event were by the following companies and topics:

- Marcus Ernst, Mack One Deutschland GmbH  
Are virtual experiences replacing the analogue park experience - Insights from Germany's largest theme park
- Michael Scholz, Founder & Creative Director halbautomaten  
KINETARIUM IS INTERACTIVE PLANETARIUM. Everyone joins in and controls their avatar on the dome. Together, puzzles are solved, secrets are uncovered and high scores are cracked. A platform for playing and learning together. Hundreds of participants can take part in real time.
- Stefan Kolbe, Head of jangled lab & Marc Schleiss, Creative Director Jangled Nerves  
Insights into the making of the 360° multimedia installation "Magical Garage" for Mercedes-Benz AG, where groundbreaking technical innovations become the star of an immersive experience. Additionally, insights into an AR application created for the Museum for Hamburg History, which brings the building's historical artifacts back to to life.
- Robin Wenk, CEO and Co-Founder LightShape  
"Sunset Gathering" - Choreography of a VR event: The "Sunset Gathering" was the evening event of the XR Expo 2020 and one of the first VR events of its kind. The lecture sheds light on the process from conception to implementation, including pain points and why Murphy's Law is always a thing.
- Andreas Siefert, Geschäftsführer Pong.Li  
topostoria™ - OneWorldGame: PONG.Li Studios' Andreas Siefert will introduce topostoria™ -

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<sup>7</sup> <https://www.linkedin.com/events/fabwxrday7125885847899385856/about/>



an innovative blend of reality and virtuality in a gamification system that elevates knowledge transfer to the level of the 21st century.

- Prof. Volker Helzle, Head of R&D Animationsinstitut

Introduction to Horizon Europe project EMIL and to FABW's Lighthouse Project "MinoXR" (working title). Insights into production process, current status and upcoming development

In the early morning we transitioned from input presentations to demonstration to have attendees test and evaluate the current state of the MinoXR Demonstrator (Figure 27). This demonstrator used 4x Vive Focus 3 HMDs that used inside-out tracking and map sharing with locally installed Unity builds of the experience and the respective hand controllers, one Asus RT-AX88U 6G Wifi Router and a Windows PC running FAAl DataHub.<sup>8</sup>



Figure 27 FABW XR DAY participants testing the MinoXR Demonstrator under director Andreas Dahn's supervision

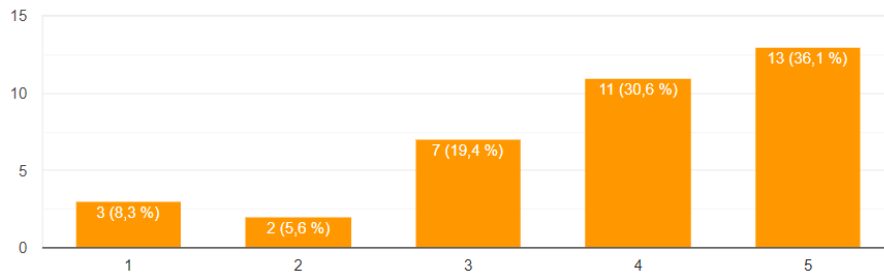
<sup>8</sup> <https://animationsinstitut.de/de/forschung/tools/tracer>



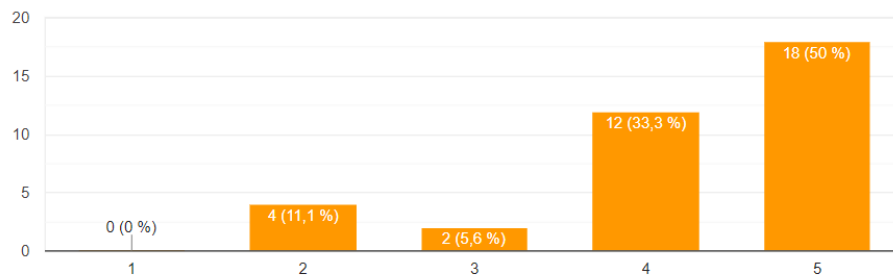
### 3.5.2 Evaluation

Participants of the MinoXR Demonstrator were asked to provide feedback via a prepared online questionnaire with answers on a 5-point likert-scale. 36 participants provided feedback during the public demonstrator shown at the FABW XR Day November 29<sup>th</sup> 2023. All participants were made aware of the work in progress status of month 15 of 30 total when asked to fill out the questionnaire. However, during discussions afterwards it turned out that a significant number of participants was not aware that this is not the final experience. The reader might keep this in mind when investigating the results of the following evaluation.

How would you rate your expertise with VR experiences?  
1 no previous experience - 5 regular user of VR experiences



Did you enjoy the experience?  
1 no - 5 yes

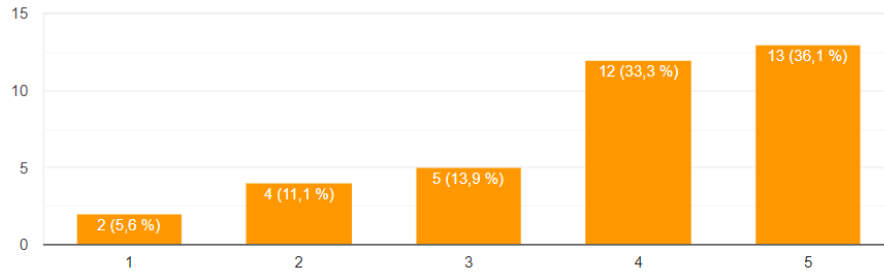




### D3.11 – Location Based Experience Demonstrator

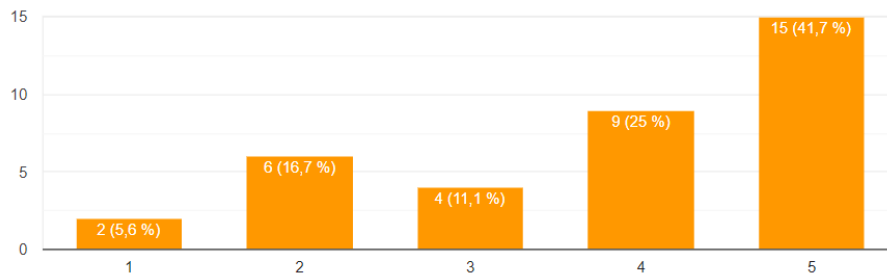
Did you encounter any motion sickness or queasiness?

1 A lot of sickness - 5 No sickness at all



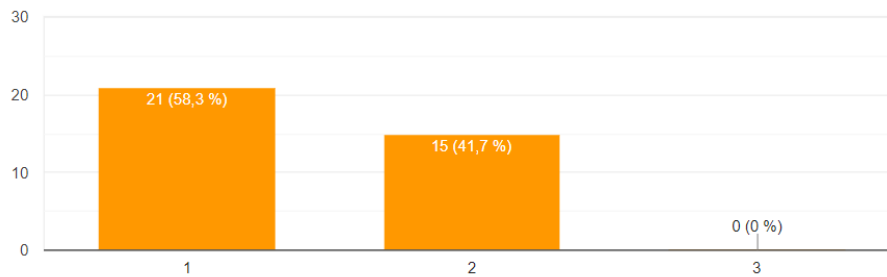
Did you feel any discomfort because of being disoriented at any point of your journey through the experience?

1 a lot - 5 not at all



Did you need external assistance to get through the experience?

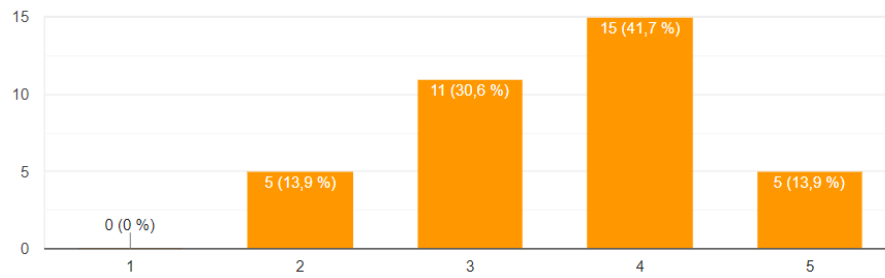
1 none - 5 a lot



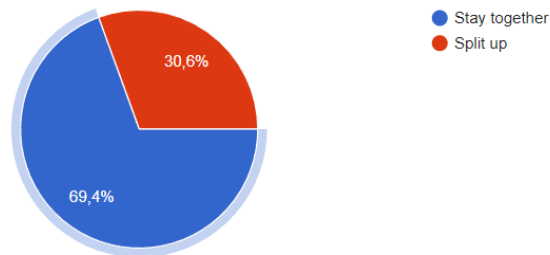


### D3.11 – Location Based Experience Demonstrator

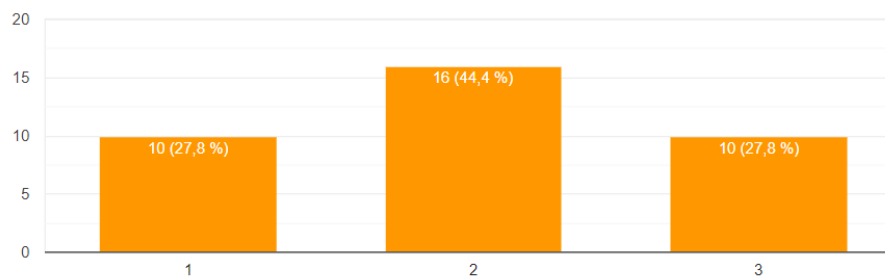
How would you rate the length of the experience?  
1 too long/too short - 5 perfect duration



Did your group stay together or split up after entering the labyrinth?



Did you run into technical difficulties during the experience?  
1 Heavy technical difficulties - 3 no technical difficulties



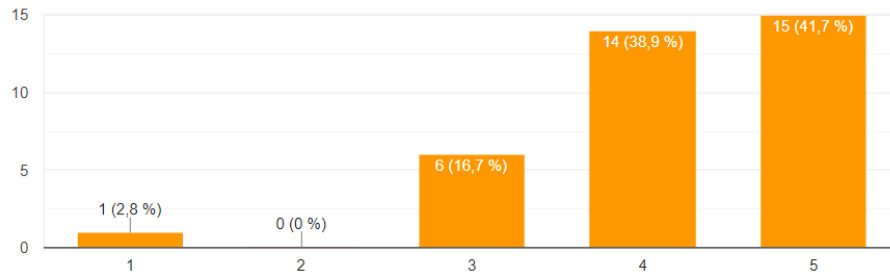




### D3.11 – Location Based Experience Demonstrator

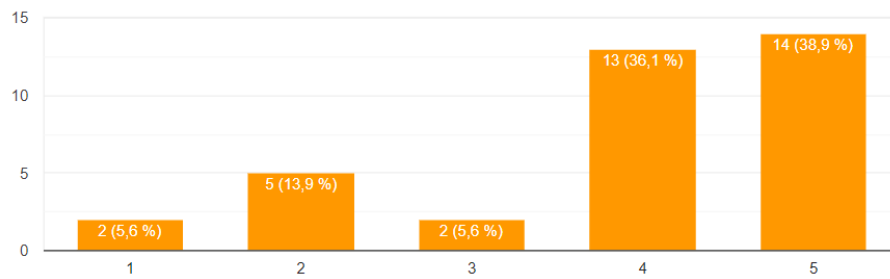
Did you find the interaction with the controllers/interactive elements difficult or intuitive?

1 difficult - 5 intuitive



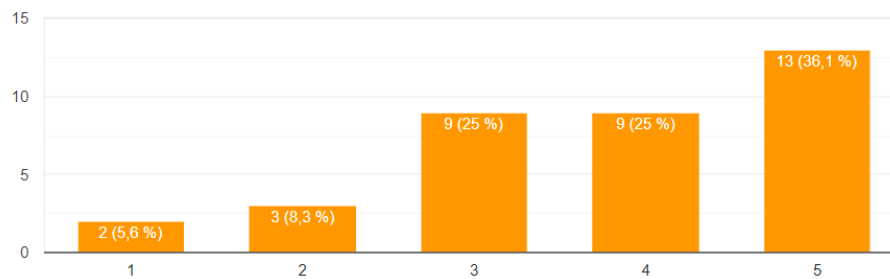
Did you understand what the encountered Greek characters said (language, acoustically)?

1 not at all - 5 yes, all of it



Did you understand what the encountered Greek characters meant (content)?

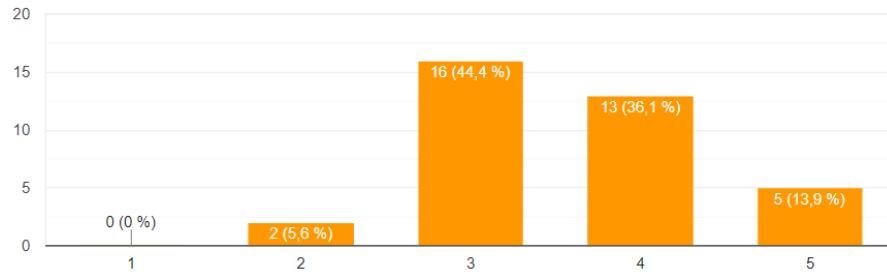
1 not at all - yes, all of it



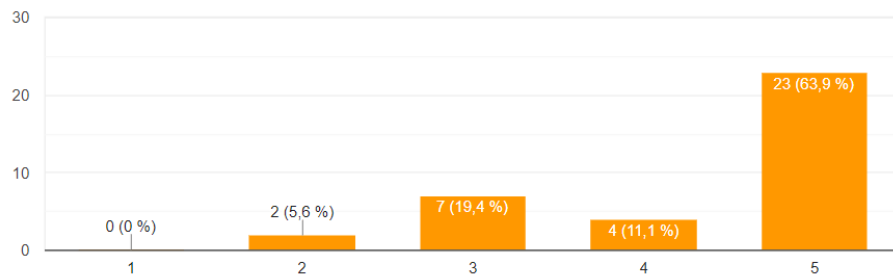


### D3.11 – Location Based Experience Demonstrator

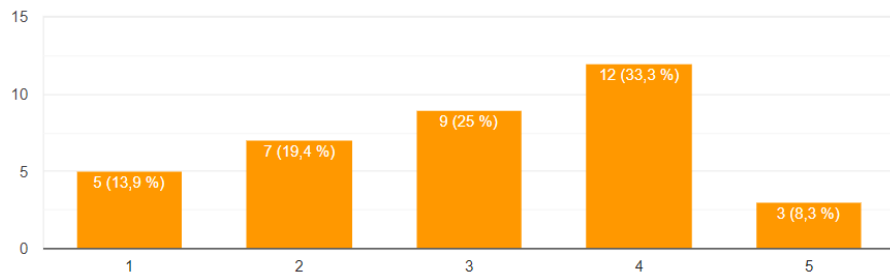
Would you prefer a different difficulty level of the experience's tasks?  
1-easier, 3-perfect, 5-more difficult



Do you feel the characters' gender types were represented suitably?  
1 not suitable - 5 suitable



How would you rate the aesthetic qualities of the experience?  
1 low - 5 high

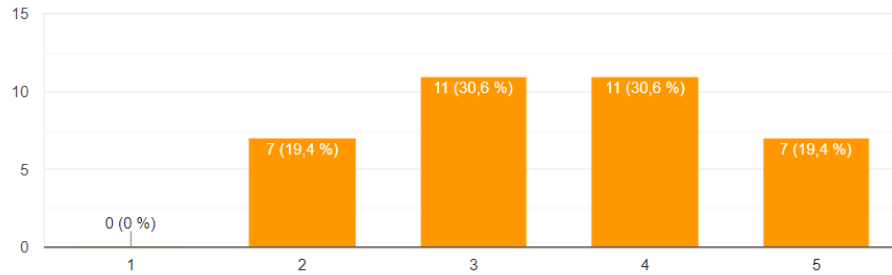




### D3.11 – Location Based Experience Demonstrator

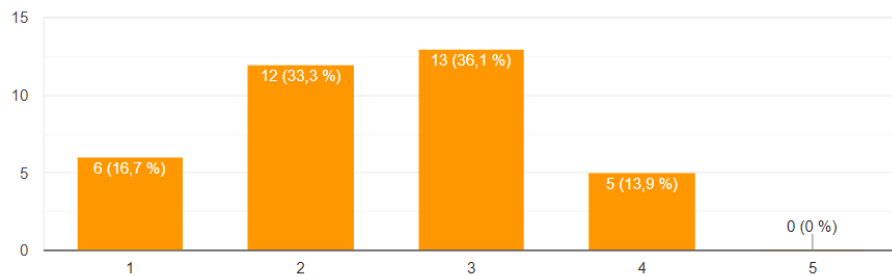
Did you feel empathy for any of the characters?

1 yes - 5 no



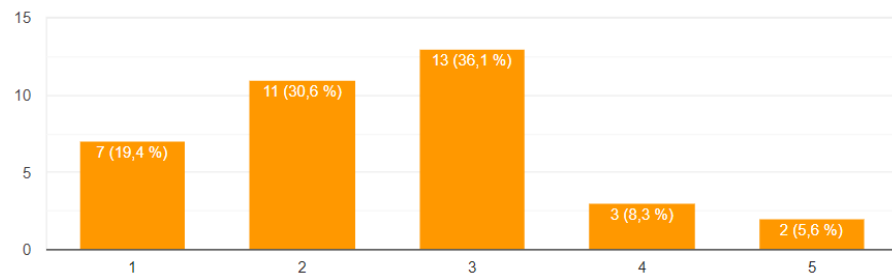
How invested did you feel with the characters' family dynamic and their personal motivations?

1 not at all - 5 very



Do you feel like you learned something about Greek mythology?

1 not at all - 5 a lot



User input question: What was your favourite interaction throughout the experience?

Answers (notice that we combined topics and translated some responses):

- The Torch (7x)
- Passing around torches
- Fighting/Sword Scenario (2x)
- The Minotaur (2x)



- Walking on planks in mid air!!!!
- Combining things together, Combining objects,
- Group interaction, Loved the interactions, Interacting with the other players
- Can't tell
- Walking on the dark tunnels and woods
- Walking around in the real world and seeing the differences in VR.
- Having a laugh at the bug we found.
- Grabbing items and lighting with the torch (revealing from black and discovering). Also, the illusion of small room which you can't get through, and the illusion of depth.
- Pushing the white heads together
- Turning the wheels and using the torch to light your way. More of that would add suspense and some jump scares or feeling threatened when going around corners in the darkness would make it feel more immersive. I felt too safe when it seemed it was a tense situation.
- Minotaurs in mid air
- Labyrinth
- Glitching through the wall
- The environment is great
- Turning wheels
- The calibration, praising the god
- Platform riddles, Changing the platforms
- Walking through narrow caves and over the high wooden path
- The moving platforms near the end
- Hovering over the labyrinth (even while it jittered)

User input question: Please let us know any other thoughts about the experience

Answers (notice that we combined topics and translated some responses):

- Great, go ahead
- Nothing
- We need to stay together during the elevator moving up which is a perhaps just a bug fix away.
- More interaction between players would be nice
- Different experience from other VR contents. But the volume of the sounds was too low that's why that I couldn't hear anything.



- Change the sentence at the wheel in the beginning. It can be confusing, because it states with the first word to turn the wheels, but FIRST if everyone is here. You can see through objects. The object interactions work great however, my torch fell through the platform and I lost it. Maybe have a backup torch which spawns when lost. Also I loved the finger guns but I immediately wanted to do more with my hands because of that. And to end the experience: we encountered a bug because of what I needed to stop my playthrough. When we entered the puzzle of the bull all pressed them once. Some pressed a second time. After that the platform started moving, but for two their camera didn't move with the platform and so they started walking against the wall. After they recognized this wasn't intended they stopped and looked after their teammates. One of them was juggling and dancing in the air which made for a great laugh. The testing was ended after that.
- Critic points: 1. UV seams visible at the boat edges and at the beginning columns is a long UV-Seam visible. Also liking the approach of drawing stylization. But it feels a bit outdated with the 2. low resolution textures and 3. the lack of shadows. Maybe painted cartoon! shadows (not realistic) on a shadow map could improve it a lot. (Especially the view on the labyrinth inside felt flat therefore.) 4. cartoon outline for character would be nice 5. The tracking felt shaky and not grounded. But I guess that's due to the limitation of the system. 6. had 2 bugs right before the minotaurus: the bone glitched away after being grabbed. Maybe another person grabbed it too? Therefore we didn't get on the elevator and got separated from two participants.
- Replace controllers by real objects
- I liked the moving platforms. Splitting up the group at one point and regrouping them later can be a strong element. I would recommend to do without controllers but to use hand tracking instead. I'm critical of the avatars: they rarely look good, there's occlusions and hardly anybody thinks they're appealing. Could you do without them?
- Fun to experience. Could have lasted longer. Less jittering would be good
- Slight tracking issues, slight aliasing, seeing the full body only on the other players is cool
- Add more danger or consequences. Something that will make it feel like I have more skin in the game (idiom) like falling if I stand over the air and maybe respawning but with less health. This may encourage the player to not try to break the game and in turn break the immersion.
- Was Funny
- Was cool
- Seems to be a lot of work ahead
- Nice hands movement and textures!
- No time to figure out the riddles by yourself.
- Pretty cool to walk around in the real space
- It was something new, something i have never seen before



- Was great and like to see more
- Was fun!
- More content plz 😊
- Very cool that it worked within the space and we stayed in the box always
- Funny, adventure
- I would like to fight the Minotaur with the skeletons hand!
- It was very fun. Would have loved to play it longer
- Lighting Leads the way.
- More action
- A great experience
- Great collaborative experience, still a little rough around the edges- looking forward to the final experience
- Great ideas for using different heights and moving between them. Very well done.
- I was taken out of immersion by all unnecessary steps, level differences
- I apparently almost ran into one of the tables but was fortunately stopped by one of the players. Perhaps a warning feature on the display would be useful for idiots like me :-). On the positive side, it meant that the experience was so immersive I actually felt like I was in character. :-)

## 4 Next steps in the development of “MinoXR”

We will put our next efforts into play-testing the experience, making necessary adjustments to optimise, polish and finalise all assets and interactions. We will further enhance the visual and auditive quality by putting more work into lighting, shading, texturing, effects, and sound design. We will optimise the whole experience for easy setup, making the LBX as bulletproof and smooth as possible. While assets are polished, we prepare the production of the stereoscopic 180° video, required for scale level 1 and for promotional by-products. Additionally, we will address the potential crossover to other EMIL lighthouse projects in particular the Magic Lantern during the onboarding process.

## 5 Conclusions

While the core framework and functionalities of MinoXR have been set up, Filmakademie’s team will continue to work on fixing known issues. The current status of the experience still lacks some work that needs to be done in regard to lighting, shading, texturing, sound design and so forth (see chapter 4). One of the key factors in polishing the experience in the course of the next 12 months will be firstly the integration of the feedback collected by the user evaluation during Nov 29<sup>th</sup> public demonstrator and secondly ongoing play testing and evaluation in the course of the coming months – both from



### *D3.11 – Location Based Experience Demonstrator*

experts, students and external evaluators who will be invited or may get the chance to experience MinoXR at conferences or events.