Novocene

An Artistic Mixed Reality Experience on the Anthropocene and a Possible Future

We are living in a geological epoch that is largely shaped and dominated by humans, and which has been proposed to be called "the Anthropocene" by Crutzen and Stoermer in 2000. This concept has influenced debates, policies, and opinions ever since then, also inspiring artists and scientists to collaborate and convey scientific data and facts through aesthetics and new media. *Novocene* is a mixed reality application dealing with the Anthropocene and a speculation about the coming world. It was developed for Meta Quest 3 in close collaboration between XXX at XXX in 2024/25. On a second level, *Novocene* traces the history of media offering an ambiguous perspective on humanity's faith in technology from radio to AI. The title is inspired by the environmental philosopher James Lovelock, who, in his 2019 science book *Novacene*, envisioned a future age of hyperintelligence as a potential solution to the human-caused crisis. Within the context of the presented interdisciplinary collaboration, the research focused on creating a balanced mixed reality art experience that fosters both playfulness and learning and reflection. The application presented is intended as a contribution to the social discourse on current socio-technological changes and challenges in the light of both the Anthropocene and the impact of artificial intelligence.

CCS CONCEPTS • Applied Computing • Arts and Humanities • Human-centered Computing • Human-Computer Interaction (HCI)

Additional Keywords and Phrases: extended reality, mixed reality, media art, interactive art, interdisciplinarity, interdisciplinary collaboration, art and tech, Anthropocene, artificial intelligence, sustainability, critical reflection

1 INTRODUCTION

The Anthropocene is a proposed current geological epoch, in which humans are the main cause of permanent earth system changes such as global warming or extinction of species [5] [17]. Although not adopted as an official category of geological time, this concept – popularised by Paul J. Crutzen and Eugene F. Stoermer since 2000 [16] – has had a remarkable impact on debates, policies, and opinions worldwide [5] [4]. As a theme of high social relevance, it has also inspired a wide range of art and culture professionals to create works that convey scientific data and facts in diverse media and aesthetics. Against this backdrop, the presented project was driven by the research question of how to communicate the Anthropocene and a speculation on a possible future through an innovative, artistic mixed reality (MR) experience in a way that is playful and still makes the audience learn and reflect. MR is an immersive technology that blends the physical with virtual worlds enabling intuitive interactions between humans, 3D content and the environment in real-time, usually developed for head-mounted displays (HMD). Building on an initial artistic concept, agile development for the Meta Quest 3 was conducted in close collaboration between the artist and the interdisciplinary research project XX at XX university from May 2024 to January 2025. The paper starts with related work in the fields of arts and science, followed by the artistic concept and details on the technological implementation. It continues with a user evaluation of the final application, the discussion of the results, and our conclusion.

2 RELATED WORK

The presented project combines critical theory, interactive MR for the Meta Quest 3, storytelling and the artist's aesthetic. Its main inspiration was drawn from the anthology Interspecies Future, ed. by McDowell et al. (2014) [10]

asking how to create a future for all species after the Anthropocene. Stöcker (2024) [22], Metzinger (2023) [11] and Garcéz (2024) [2] also contributed to the philosophical framework of the project.

There are other extended reality (XR) and audiovisual artists who have dealt with the Anthropocene as part of their artistic research and work relevant to this paper. Current (2024) is an interactive augmented reality (AR) sound experience by Anke Schiemann and artist She's Excited [19]. It draws attention to oceanic currents, their importance and fragility menaced by man-made changes such as global warming and invasive species. I Pity the Garden (2022) by Mariam Natroshvili and Detu Jincharadze is a virtual reality (VR) experience for the Meta Quest 1 leading into the Anthropocene with signs marking the end: a horizon on fire, an abandoned city, etc. The setting reminds of an abandoned video game where only traces, irreversible mistakes, and wounds in the earth can be seen [15]. The interactive AR experience Sacred Grounds (2022) by the artist collective Refrakt sets the focus on social, economic, and environmental consequences of the production of media technologies, criticizing the problematic conditions of mining the necessary resources [31]. Digital Atmosphere (2020) by Studio Above & Below is a MR sculpture for Magic Leap that reacts to a city's air pollution in real time and translates it into an evocative visual simulation [23]. For Seasons (2019) by Kling Klang Klong for the NDR Elbphilharmonie made climate change audible through an update of Antonio Vivaldi's famous violin concerto using algorithms based on climate data [7]. The Anthropocene Project (2018) from Nicholas de Pencier, Edward Burtynsky and Jennifer Baichwal combines art, film, virtual reality (HTC Vive), AR, and scientific research to investigate human influence on the Earth and its future [17] [14]. Extinction Park (2018) by Lara Torrence is a VR experience for HTC Vive and Oculus Rift showing a virtual graveyard created after Sudan, the last male northern white rhinoceros, died in March 2018, whose species had lived for millions of years but could not survive mankind [24]. There are also studies dealing with man-made planetary changes (cf. [3] [6] [9] [13] [18] [20] [29]) emphasizing, among others, the potential of XR and gaming for conveying challenges coming with the Anthropocene. Artistic MR applications for the Meta Quest 2 include Am Ende der Welt (2023) by artist Norah Krahl and her team in collaboration with XX university, also addressing the future of a technologized humankind. Another example is Animate (2022), an "immersive AR radio play" by Chris Salter and collaborators [12]. For the Meta Quest 3, no comparable applications are known to the authors.

While AR and VR have been explored for decades, true MR has only recently become more compelling due to advancements in passthrough-capable HMDs [21]. Earlier optical see-through HMDs such as the Microsoft HoloLens or Magic Leap One, and the mono-passthrough Meta Quest 2 were still comparatively limited in their MR capabilities [30]. More recent systems, such as the Meta Quest 3, improved on these limitations, offering stereoscopic color passthrough, spatially stable content and seamless interactions between the virtual and physical [25].

3 ARTISTIC CONCEPT

Novocene unfolds a narrative of approximately 15 minutes structured in 4 scenes. It is a story about the development of humanity in the Anthropocene contrasting its manifestations with an utopian speculation on the future. The title refers to the environmental philosopher James Lovelock, who, in his science book Novacene (2019) [8], envisioned a future age of hyperintelligence as a potential solution to the human-caused crisis. The MR experience starts with a HMD that lies on a physical tree stump sculpture in an exhibition space inviting the visitor to put it on (fig. 1). Seen through the HMD, scene 1 shows the untouched natural state of the Holocene, just before humanity's global impact. The player perceives an old-fashioned radio that they interact with by pressing buttons to advance the narrative: The stump sprouts young, virtual shoots and branches, growing to new life. Once the player waters the ground using a virtual watering can, plants begin to grow around the tree (fig. 2), accompanied by a reduced and reflective storytelling, for example:

"Please keep on watering to let more plants grow. Nature has always been such a diverse paradise for so many species. We find ourselves in a relational space between lifeforms and interconnected with all living things. [...] Perhaps it's time to cast aside hierarchies that put humans against nature, nature against technology, and technology against life." [26]


Fig. 1 and 2: The HDM on the tree stump sculpture in the exhibition setting; the interaction with the virtual water can. Photo and screenshot: the artist

Dedicated to the Anthropocene, scene 2 traces the onset of increasing exploitation of natural resources. A television appears, providing informative facts and numbers about deforestation and climate change. A flashlight can be grabbed to iluminate the scenery and to discover five figures that personify humans and their activities through the ages. Human-induced wildfires consume the grown vegetation, the player can try to extinguish them with the watering can. In parallel, virtual devices like a radio, television, computer monitor and chatbot symbolize media evolution reflecting a belief in progress intertwined with media development. Ultimately, they will merge into a slot machine-like apparatus that generates counter-narratives to conventional patterns and clichés. Scene 3 is marked by a catarsis: The tree is cut down, increasing temperatures lead to visibly melting pole caps and a rising sea level. The player finds themselves in a MR underwater scenario where the previously introduced objects and game elements float around them. The final scene reflects the *Novocene*, the Anthropocene's future. As the artist points out, the current hype around artificial intelligence (AI) makes the promise of hyperintelligence especially relevant. Critics view AI as the latest in a series of techno-utopian trends while also highlighting its environmental cost, particularly due to high energy consumption and emissions. This tension is visible in the project: The artist used AI tools to co-create content, simultaneously critiquing the problematic aspects of AI that shaped the narrative and its final statement: The screens of the virtual devices promise solutions to environmental and climate issues, yet the player is surrounded by deforested nature, with trees replaced by technology. This contrast forms the central motif of the immersive installation. In the end, the player interactively constructs a monument for an alternative future from the artefacts and totems of the Anthropocene's civilization.

4 TECHNOLOGICAL IMPLEMENTATION

The MR experience was developed using Unity, a widely adopted real-time 3D engine, chosen for its flexible support of both immersive storytelling and experimental interaction design. It was targeted at the Meta Quest 3 HMD, utilizing the *Meta XR SDK* to enable MR features such as passthrough rendering and scene understanding, crucial components for blending virtual elements with the physical environment in a coherent and meaningful way.

4.1 Storyboard-Driven Architecture

The creative foundation of the experience is a four-scene storyboard authored by the artist collaborator. Each scene describes asset placement, available player interactions, ambient soundscapes, narrative triggers and estimated duration in detail. To ensure this artistic intent remains central throughout development, a *State Machine* pattern that directly reflects the storyboard structure was implemented. Each scene is divided into uniquely defined states, which map to specific moments of player interaction or timed narrative progression. This structure not only enables precise control over pacing but also makes the story progression more easily testable and adjustable during the development process. Every state defines two key behaviors: entering the state, where all relevant objects (e.g., 3D assets, audio, interaction zones) are initialized and positioned; and skipping the state, which enables a rapid iteration workflow to skip to currently tested states. Progression between states is either interaction-driven, such as a player grabbing an object, or dictated by timed media content. For the latter, audio and video wrappers that attach to each media source and detect playback completion were introduced. To further support artistic control, each state receives a configurable serialized data file, which allows adjustment of timing parameters, audio triggers, and asset references without recompiling the application. This empowers the artist to directly influence the pacing and rhythm of each scene, fostering an iterative and collaborative fine-tuning process without additional developer intervention.

4.2 Visual Storytelling

A core concern was the interrelation between virtual and physical worlds and how human decisions alter our shared environment. This was realized through the integration of passthrough and scene understanding capabilities from the *Meta XR SDK*, enabling virtual elements to coexist meaningfully and responsively with the player's real-world surroundings. To integrate virtual content with the physical surrounding, a virtual copy of the physical environment is imported as a mesh using the *Mixed Reality Utility Kit (MRUK)*. A passthrough shader applied onto that mesh displays the Meta Quest 3's camera feed, effectively projecting the real-world environment into the 3D scene. The created mesh also provides colliders and depth information, occluding virtual content behind physical one. This layering approach allowed environmental effects, such as debris, foliage, and atmospheric lighting, to integrate naturally and interact with the perceived physical world. Using a custom anchoring solution, players can also position and resize the virtual environment within their physical one, to ensure the visual storytelling can be experienced both in a small living room as well as an exhibition hall.

Significant turning points in the storyboard were conveyed using a combination of physics-based interactions and shader-driven visuals. For instance, in one scene a ceiling cutout is placed into the physical roof by raycasting against the mesh's colliders. A stencil shader applied to this cutout subtracts the passthrough layer, revealing a virtual skybox above. This creates a striking visual where a growing tree appears to pierce through the ceiling of reality (fig. 3). Another example is the portable flashlight, constructed by layering two passthrough channels: a darkening background filter layer and a clear cone-shaped passthrough spotlight in the foreground (fig. 4).

In the final two scenes, the world becomes submerged. This effect, created using a vertex-displacement gradient texture applied to a plane mesh, is enhanced by a blue color filter on the passthrough background, dimmed ambient lighting, and the deep rumbling of surrounding water. Objects in the environment respond physically through a lightweight buoyancy simulation: random horizontal and vertical forces, along with torque, are applied to each object, guiding them toward a target vertical position, either the water's surface for normal objects or the player's torso height for interactable ones. This reinforces the sensory experience of flooding not just as a visual shift, but as an embodied transformation of the environment.

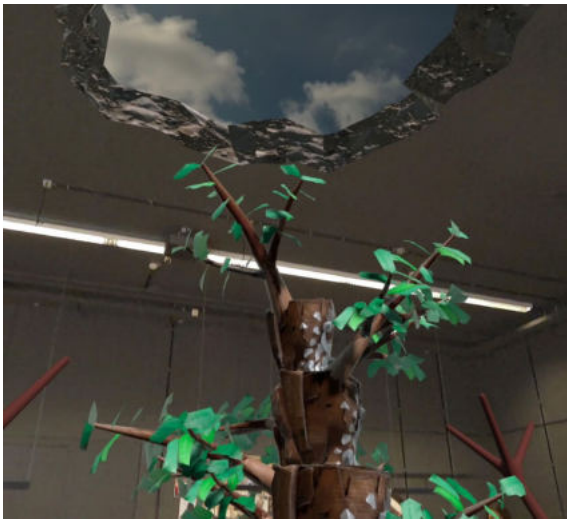

Fig. 3 and 4: Ceiling cutout in the physical roof; the portable flashlight effect. Screenshots: Project XX and the artist.

4.3 Use of artificial intelligence

Various AI tools were used to generate images, videos, sounds, and 3D models for the visual environment. Some interactable objects, such as a tree stump and a watering can, were first built from cardboard, then photographed from all sides using the AI-supported smartphone app Kiri-Engine[1] and automatically converted into 3D models with minimal post-processing. For the chatbot character, Tencent's Hunyuan3D-2[2] generated full 3D models from multiple images. The reference images were created using platforms such as Adobe Photoshop,[3] Midjourney,[4] and Dall-E 3,[5] allowing the artist to experiment with different styles for characters, plants, and textures. This material also appeared in videos shown on screens and televisions within the virtual environment, which help drive the narrative. Using Runway,[6] faces and

[1] https://www.kiriengine.app (last access: 16.05.25).

[2] https://huggingface.co/spaces/tencent/Hunyuan3D-2 (last access: 16.05.25).

[3] https://www.adobe.com/products/photoshop.html (last access: 16.05.25).

[4] https://www.midjourney.com/home (last access: 16.05.25).

[5] https://openai.com/index/dall-e-3 (last access: 16.05.25).

[6] https://app.runwayml.com (last access: 16.05.25).

figures were animated and made to speak, while image-based action scenarios were generated. Dialogue for the narrative characters was voiced using Elevenlabs.io.[7]

5 EVALUATION

Within the iterative approach, the application was tested and optimized regularly. For its final evaluation, an individual mixed-methods questionnaire was filled in by 14 test persons of different ages and previous knowledge in XR. Gender was not evaluated. The test persons were between 14 and 58 years old (average 36.4). Regarding previous XR experience, three of them stated to have none (ages 16, 38, 44), four to have some (ages 14, 35, 35, 55, 56, 58), and five to have a lot (ages 26, 27, 28, 33, 45). The questionnaire included the following four questions:

1) Where do you place yourself between concentrating on the narrative and concentrating on the interactions with the 3D world?
2) Was your focus more on the joy of the experience or on the serious message (Anthropocene)?
3) Do you think that there is added value in combining a gaming art experience with a serious topic?
4) What did you associate with the materiality of the 3D objects and how did you perceive this aesthetic?

For questions 1–2, there was a 7-point scale, and question 3 included checkboxes for yes/no/undecided with the option of giving reasons. For question 4, there was a text field for the tester's association as well as checkboxes for positive/negative/undecided. The questions reflect the main research interest in the tension between playfulness and learning/reflecting on a serious topic. The perception of the esthetics was relevant in the context of the project being an artwork.

Evaluating the answers, question 1 was answered with 7 of 7 scale points (max. concentration on the interactions) by 1 person, with 6 points by 4, with 5 points by 3, with the median by 4 persons, and 2 points by 1 person. One person did not answer this question. In total, the majority of 8 testers indicated that they concentrated more on the interactions with the 3D world, 4 lay in between, while one person clearly concentrated on the narration.

Question 2 was answered with 7 of 7 scale points (max. focus on the serious message) by 1 person, with 6 by 1, with 5 by 1, with the median by 2, with 3 by 5, with 2 by 2, and with 1 by 2 persons. Here, the majority of 9 testers stated that they focused more on joy, 2 lay in between, while 3 persons rather focused on the serious message.

Question 3 was answered with "yes" by all test persons giving freely formulated reasons such as conveying and learning serious themes easier in combination with enhanced memory performance, joy, or new perspectives through storytelling, and "low-threshold awareness" [27].

Question 4 was answered with associations like "nature", "real", "human-made", "woodcut/nature/artificiality", "retro, paper, abstraction", "dystopian" or "post-futuristic" [27]. Although associated more diversely than expected, 12 persons evaluated the artistic aesthetics positive, 1 both positive and negative, and 1 person was undecided.

6 DISCUSSION

The questionnaire was completed by 14 persons which can be considered as a limitation of the general informative value of the study, more participants would certainly have produced clearer results. Nevertheless, the answers revealed some noticeable tendencies and informative insights: The majority focused more on interacting with and enjoying the

[7] https://elevenlabs.io (last access: 16.05.25).

3D world than on the narrative and its serious topic. Still, 23% (question 1) and 42% (question 2) of all testers were only 1 point away from the ideal median. Thus, together with the testers who achieved the median – 28% for question 1 and 14% for question 2 – in total 51% of the answers to question 1 lay between 3 and 5 points, and the same is true for 56% of the answers to question 2. These players had quite a balanced experience between playfulness, and learning and reflecting. Regardless of age or prior knowledge, all testers agreed that combining gaming art experiences with serious topics adds value. *Novocene* was created neither in an educational context, as with the MR game Geome [13], nor in a gaming context, as with Never Alone [20], but rather as an immersive MR artwork that reflects socio-technological developments and, hopefully, supports the social discourse on the challenges of the Anthropocene and possible futures. In this sense, it contributes to the discussion of art's role in conveying these themes, as discussed by Bruhn (2020) [1] and McDowell at al. (2024) [10], and broadens the perspective on already existing artworks in XR and the newest interactive MR experience presented. The blending of realities in MR supports the artist's vision of a layered ecological narrative, where remnants of the present world persist and morph under speculative climate conditions as predicted by research. It transforms the player's own space into a canvas for narrative intervention, opening new forms of embodied, participatory storytelling in a way that the linear story is pushed forward through interaction. Here, the player does not merely observe a fictional world, they inhabit one that reacts to them and reflects the consequences of human impact. The analog tree stump sculpture links the hybrid experience visibly to the physical space avoiding an exhibition setting that only consists of HMDs and optional screens.

7 CONCLUSION

Novocene is a mixed reality artwork with multiple layers. It combines interactive playfulness with scientific facts on the Anthropocene's consequences, artistic reflections on human faith in media from radio to AI, and speculations about a possible future. As the artist explains, he wanted to "strike a fine balance, hopefully somewhere between instruction and fatalism on the one hand and naïve ignorance and faith in technology on the other" [28]. The main challenge in the interdisciplinary research was finding the right balance between playfulness and joy on the one hand and reflecting and learning on the other. In a mixed-methods questionnaire, 14 testers provided information about their behaviour and perception when experiencing *Novocene*. Most of them stated that they focussed more on playfulness/joy while a majority of 51% resp. 56% located themselves more or less well-balanced on the scale points 4 +/-1. In total, all testers gave encouraging positive feedback regarding the added value of the pursued approach and its result. Further research could focus on the role of analog elements and exhibition settings for the user experience, such as the tree stump sculpture included in *Novocene*. In this context, analog haptics could be a valuable augmentation of the audiovisual experience.

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