The Area of the Virtual

About the Collision of Spatial Perception and Spatial Projection in VR

Manuel van der Veen

This chapter begins with a brief overview of artworks that employ head-mounted displays. The purpose of this overview is to illustrate how the use of VR in the field of art has developed in different directions in recent years. These developments not only build on what has already been done, but also undermine the very foundations of VR, particularly its spectacular immersion of the viewer into an image.[1] Today, there are even cases with VR in which users cannot enter the virtual space at all. Instead, they can only view it from the outside via a second screen. For example, Hayden Fowler's *Together Again* (2017) which takes place in a cage (fig. 1a).[2] By referring to Joseph Beuys' performance *I like America and America likes me* (1974) with a coyote, Fowler got himself locked up with his dingo. The artist wears a headset and different tracking devices are attached to the dingo. Only a small second screen in the corner of the cage provides insights into a virtual desert and thus into what the artist sees through the glasses. While the cage remains invisible to Fowler, the dingo cannot perceive the virtual world. Although the artist and the dingo can still sense each other through touch and smell, and, thanks to the tracking devices, the dingo is represented as a digital double in the desert, both are still trapped: the dingo in the cage and the artist in the hermeticism of VR. Only the viewers are able to watch the entanglement of the two enclosures – beyond immersion. They can look at the screen to see into VR and through the bars of

1 Cf. David J. Chalmers (2022): Reality+. Virtual Worlds and the Problems of Philosophy, New York: W. W. Norton & Company, especially the Ch. »Do virtual reality headsets create reality?«.

2 I would like to thank Julia Reich for bringing this work to my attention.

the cage. In addition to this special case of inaccessible VR, there are site-specific VRs today, in which a digital space is accurately adapted to the exhibition space. Furthermore, there are virtual worlds that still enclose viewers, while at the same time they are perforated with small windows through which the actual surroundings can be seen. There are VRs which include actual objects that can be touched and used and there are works of art that couple VR with augmented reality (AR) and machine learning.

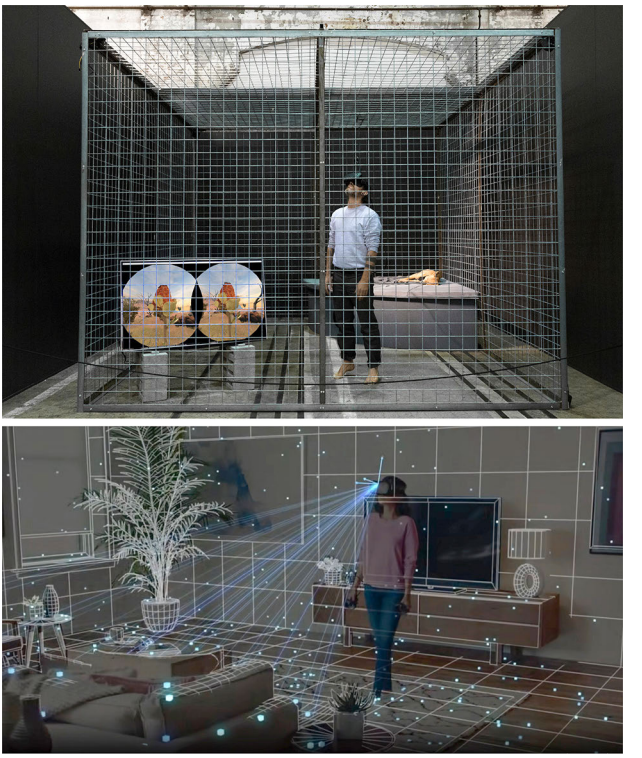

fig. 1a&b: above: Hayden Fowler: Together Again, 2017, installation, performance, HTC Vive, installation view: Sydney Contemporary, Carriageworks; below: Screenshot from the video: Powered by AI: Oculus Insight

These examples are variations of VR that combine different characteristics of extended realities (XR) and experiment with transitions between varying procedures. They indicate a tendency that is even more evident because it has a parallel in technical development. Over the last years, artists have been confronted with headsets that can be used for all XRs due to their integrated *passthrough mode* and advanced spatial sensors.[3] Current glasses make it possible to realise virtual, augmented, and mixed realities with a single device. Therefore, one could ask: what does it actually mean to say VR? What significance does such a concept still have? And does it even make sense to talk about VR when all the examples mentioned above are subsumed under it?

In an updated version of Paul Milgram and Fumio Kishino's virtuality-reality continuum, created by Richard Skarbez, Mary C. Whitton and Missie Smith, VR is completely excluded, as there is no experience that is purely ›virtual‹.[4] However, Hayden Fowler's example cannot be positioned in any of the classification systems, nor do they allow for asymmetries. In addition, it must be said, that VRs that cannot be entered, VRs that are site-specific, or VRs that integrate windows into the exhibition space, all lead to completely different art-historical questions. Paulien Dresscher and Nana Verhoeff even state that the X in XR refers to the great unknown, »as to indicate that the emerging entities cannot be predicted or are not (to be) predetermined.«[5] In order to avoid leaving the status of XR completely uncertain, I would like to introduce my concept of *areal space* in this chapter, which unfolds a fundamental condition for these technologies while maintaining the necessary openness of the virtual. This *areal space* is a concept that addresses the aforementioned ambiguity and allows for a more theoretical and art-historical classification of the various procedures, whereby it also explicitly refers to technical characteristics. In German, ›area‹ is called *Areal* which connects a spatial area with

3 Cf. Julia Reich/Annette Urban/Manuel van der Veen (2023): »passthrough. Von Portalen, Durchblicken und Übergängen zwischen den (virtuellen) Welten«, in: Kunstforum International 290, pp. 86–95, and also see Chris Salter's discussion on the HMD in this volume.

4 Cf. Richard Skarbez/Mary C. Whitton/Missie Smith (2021): »Revisiting Milgram and Kishino's Reality-Virtuality Continuum«, in: Frontiers in Virtual Reality 2, n.p. and see also Paul Milgram/Fumio Kishino (1994): »A Taxonomy of Mixed Reality Visual Displays«, in: IEICE Transactions on Information and Systems E77-D/12, pp. 1321–1329.

5 Paulien Dresscher/Nanna Verhoeff (2020): »XR. Crossing and Interfering Artistic Media Spaces«, in: Larissa Hjorth/Adriana de Souza e Silva/Klare Lanson (eds.), The Routledge Companion to Mobile Media Art, New York: Routledge, pp. 482–92, here: p. 483.

a-reality, i.e. with the unreal. As a matter of fact, the term a-real is not the negation of the Latin word *realitas*. To paraphrase the French philosopher Jean-Luc Nancy, one could nevertheless call this a lucky circumstance that is being exploited here:

> »Areality is an antique word, signifying the nature or specificity of an aire (›area‹). By chance, this word also serves to suggest a lack of reality, or rather a slight, faint, suspended reality: the reality of a swerve localizing the body, or a displacement within the body. In effect, a faint reality of ground, substance, matter, or subject. But this faint reality makes the whole areal real, where the so-called archi-tectonics of bodies is played out and articulated.«[6]

While Milgram and Kishino distinguished between the ontological categories of ›real‹ and ›virtual‹, the updated version is framed between the reception-aesthetic category of ›immersion‹ and the production-aesthetic category of ›extend of world knowledge‹[7]. The concept of *areal space*, in contrast, is based on a technical specificity of current technologies of virtuality in order to proceed with it theoretically and aesthetically.

This specific feature is that all procedures – whether virtual, augmented, or mixed reality – are both space-perceiving and space-projecting.[8] Following this feature means that none of the XR completely excludes the outside space and that none shows the outside space as it is. This is because all XR perceive the surrounding space in a certain way and project a specific spatiality of their own. In VR, for example, the space is constantly perceived via spatial recognition (fig. 1b). Indeed, it is precisely in this process that a 3D model of the actual surroundings is generated, but not for the purpose of archiving it or transporting it to another location. Instead, this very 3D model is invisibly projected onto the environment in order to mediate between human and machine perception. Depending on the situation, the boundaries of the spatial model can either coincide with

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6 Jean-Luc Nancy (2008 [1992]): Corpus, New York: Fordham University Press, p. 43.

7 In R. Skarbez/M. C. Whitton/M. Smith: Revisiting Milgram and Kishino's Reality-Virtuality Continuum, the authors mix the modality of experience ›immersion‹ with the aspect of ›extend of world knowledge‹, which refers to what the machine knows about the world.

8 I proposed this feature in my lecture *Placing Things Beside Themselves. ›to see how they hold up‹ (Georges Braque)* for AR and have continued to develop it since then. The talk was given as part of the international conference *THINGS BESIDE THEMSELVES* at Bauhaus University Weimar (Research Group Media and Mimesis) in February 2020.

those of the actual environment, or mark a smaller area within it. For example, with Meta Quest's Guardian, a safety feature, users mark an area around the available space in the room, which then becomes a kind of cage, as in Hayden Fowler's case.[9] The spatial reference to the immediate surroundings is active in all variants of XR. This also applies if the actual surroundings are subsequently obscured by a second projection; in the case of VR, this is the visible enveloping projection of a virtual world. A technical specificity of XRs is their space-perceiving and space-projecting property, which takes place even before virtual objects or virtual worlds appear. Hence, a major part of their aesthetics results from the relationship, dependence and collision between the perception and projection of space. The concept of *areal space* is based on this technical specificity without using any ontological attributions such as being virtual. The concept is proposed here because it allows for comparisons with other art historical concepts, enables individual XRs to be positioned in relation to one another, and provides a basis for theoretical connections.

In the first section, the concept of *areal space* will be developed in general terms, in order to elaborate on a more specific VR area in the second section, which will be discussed with regard to individual artworks that intertwine the virtual area with an exhibition's architecture. The two works discussed, one by Karin Sander and one by Theodoulos Polyviou and Eleni Diana Elia, additionally refer to traditional techniques, such as the floor plan and the magic circle. Since ancient times, these techniques have mediated different dimensions of space, similar to *areal space*, thus establishing a bridge between history and latest technology.

1. What is an *Areal Space*?

The *areal space* is based on the interplay between spatial perception and spatial projection through technology. This is a concept that I developed during my research on AR.[10] It became increasingly clear throughout this research, how AR, perhaps more than related procedures, reveals fundamental aspects of XR. The

9 For a more in-depth analysis of the Guardian, see Stephan Günzel's contribution to this volume.

10 Cf. Manuel van der Veen (2025): Augmented Reality, Leiden: Brill/Fink, https://doi.org/10.30965/9783846769409, especially Ch. 2 »Kollision von Bild und Umgebung. Die Errichtung des Areals«.

following will show that the above-mentioned varieties of VR are only possible because they are based on augmentation processes as well. If one looks at conventional understandings of AR and VR, both have of course different tasks: AR embeds an image object into the existing surroundings, while VR replaces the existing surroundings with a virtual world. But if one thinks about what enables AR and VR, it is noticeable that they share the same properties. In VR, the image stays at its place even if one turns the head or if one moves through the virtual world, and so does AR. One can circle a digital object with a tablet in hands, while the object stays at its position in the actual surroundings. This is possible because the devices know where they are as a result of the 3D model of their surroundings. This is the first condition that AR and VR have in common: for both tasks – the creation of a world or the embedment of a single image object – the technology has to perceive its own position in space in relation to the actual surroundings. A condition that is more obvious with AR than with VR. The second condition they have in common is that they both project and thereby create space, which is in turn more obvious for VR and at least confusing for AR. Nevertheless, there exist a number of investigations in art that highlight precisely these conditions.

In the AR experience *Gold Environment* by artist Chiara Passa, the actual surroundings are gradually covered with golden plates, which then serve as a breeding ground for fictional plants (fig. 2a). Passa makes what happens in the background of every AR application visible. With AR, the surroundings are perceived by a LiDAR scanner and/or plane detection and subsequently are converted into a spatial model, which is then projected back onto the surroundings through alignment. Thus, the golden surfaces simultaneously materialise the alignment and creation of the spatial model. They demonstrate how the representation of space superimposes the represented space to produce a double ground. They also demonstrate how the detailed and crowded environment is transformed into an abstract sculptural relief. In conventional AR applications, the surroundings can only be seen through the real-time video image, which obscures the fact that they are also modeled and shaped in the background of AR. An artificial ground that completely overlays the actual one. In this way, the exterior space in *Gold Environment* is increasingly covered by this double ground until only a golden environment remains visible, thus gradually staging the transition from AR to VR.

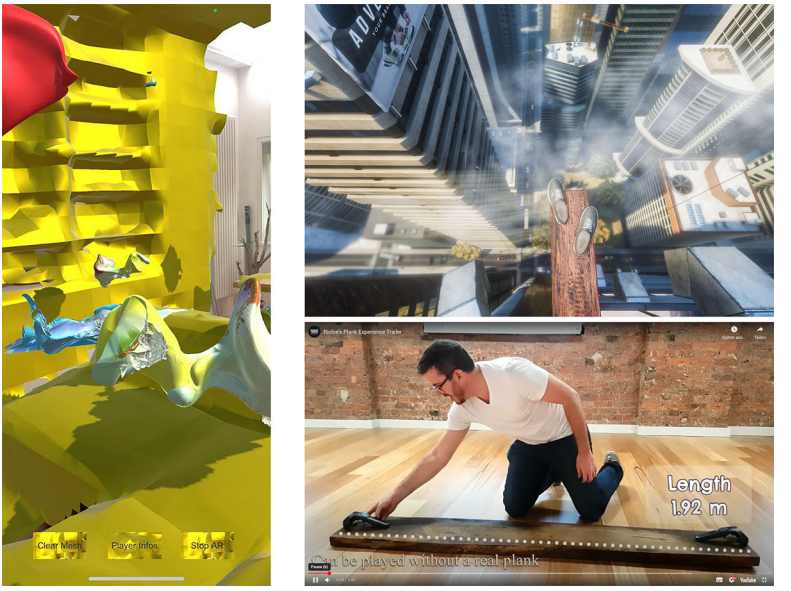

fig. 2a-c: left: Chiara Passa: Gold Environment, 2022, AR; right: Screenshots from video: Richie's Plank Experience Trailer

However, this 3D model of the actual space is always visible in AR as the negative space surrounding the digital objects. This becomes particularly obvious when shifts occur between the spatial model and the surroundings, causing the digital objects to shake, revealing their uncertain positioning between different areas. The superimposition of the represented space by the spatial representation creates a floating ground that can be congruent or slightly offset. In the latter case, corners turn into virtual curves, objects seem to float or pass through the solid walls. Firstly, this is important because if the 3D model does not appear to be completely congruent with the actual space, conflicts become apparent that fundamentally determine AR. Thereby, it reveals the differences that constitute the aesthetically relevant distance between the multiple dimensions. Secondly, this is important since the double ground is the foundation of the *areal space*.

1.1 Theory of the Double Ground

Before discussing different variants of the double ground in VR, this section first considers the double ground in theory. According to Nancy, the ground is of relevance to technology in general. More precisely, he uses the ambiguity of the term foundation (*Grund*)[11] to specify the Aristotelian concepts of *phýsis* and *techné*. The ambiguity of foundation is thereby understood »in the sense of the ground and in the sense of the principle of reason [i.e. *Grund, im Sinne des Bodens und im Sinne des Satzes vom Grund*].«[12] In English, this connection of ground and reason is part of the term ›explanation‹. Literally, to explain means to expose a plane. The roots lie in *ex-* for ›out‹ and in *plānus* for ›plane‹ or in *plicare* for ›to unfold‹, which therefore means ›to make something flat‹, i.e. to flatten a complex meaning. Hence, according to Nancy, *phýsis* (nature) could be understood as something that is a foundation for itself. This means that it grows from its own ground and finds its purpose in itself. *Techné*, on the other hand, is the area in which something is produced for which the foundation is not already given, as the foundation still must be found or invented. This is also where art and technology meet; in both fields, objects are created for which there is no foundation, no reason, no ground. All the various meanings of ›Grund‹ are important to subsequently identify art as a productive technique of foundation. Nancy also typifies art as production of presence by combining it with the act of »taking place«[13]. With other words, ›taking place‹ as the establishment of a foundation finds a place for something for which there is no ground.

In his considerations, Nancy mentions Aristotle's example for technique, i.e. the bed, and adds that for the bed there is no reason. Of course, there is a reason and a need for the bed, but people could just as easily sleep on the ground. For those who do not want to sleep on the ground, one must create

11 Cf. Gottfried Boehm (2012): »Der Grund. Über das ikonische Kontinuum«, in: Id./Matteo Burioni (eds.), Der Grund. Das Feld des Sichtbaren, Munich: Wilhelm Fink Verlag, pp. 29–91.

12 Cf. Jean-Luc Nancy (2008): »Destruktion als Erinnerung der Struktion oder Techné«, in: https://ifm.rub.de (27.11.2008). Online: https://ifm.rub.de/2008/11/1012-jean-luc-nancy-zu-gast-im-bkm/, 00:38:10 (last access: 10.10.2025), translation by author.

13 ›Taking place‹ as *stattfinden/eine Stätte finden*, which means ›to find a place‹. Cf. Jean-Luc Nancy (2013): »The Technique of the Present«, in: Documents of Contemporary Art 4/2013, pp. 104–115.

an artificial ground with the bed.[14] There is only a minimal difference between this foundation and the ground, for it is simply an elevated ground. Consequently, the bed is a duplication of the ground, cut-out and raised. In this respect, for Chiara Passa's *Gold Environment* the double ground of AR could also be understood as a technical foundation, just like the bed. Since digital things and spaces do not actually have a specific place, an artificial ground is laid out in situ with the 3D model on which they can be embedded in order to take place. This is one of the reasons why these technologies raise questions about what it means today for something to exist, to happen, to be present, to take place.

In VR, a projected space dominates, covering the entire field of vision, but what remains palpable is the double ground on which the user stands. Due to the encompassing virtual world, the perception of the outside world via VR technology usually quite literally fades into the background. The dominance of the projected space obscures the fact that for the enclosure of a virtual world, the surrounding space is also measured by cameras and sensors. With regards to the double ground, *Richie's Plank Experience* is one example that comes to mind. The popular app is based on a rudimentary approach, as the alignment of the spatial model is done manually rather than technically. Despite, or perhaps because of its simplicity, one could say that this game provides the scene of the *areal space*, or at least a scene in which shifts occur between the *areal space* of AR and VR. In this VR game, users take a lift to the 80th floor of a building, where they step out of the lift onto a plank at a dizzying height (fig. 2b). Even though they are still on the ground floor in reality, sweat is dripping from their foreheads and sticking on their hands and feet, as the fear of virtual heights has an actual effect. The effect is intensified with every cautious step on the plank. The app can be played only using a headset, but the developer's video shows how an actual plank can be added. A piece of wood that is 192 cm long, 18 cm wide and 4 cm high (fig. 2c). The plank provides a small rectangular area that, in Nancy's words, creates »a slight, faint, suspended reality«. And this wobbly, four centimeters raised ground makes it possible to experience the entire difference of 80 floors in the virtual realm. Users only slightly leave the ground of reality and yet find themselves in a different world.

14 This artificial ground shifts the underlying causes rather than resolving them. People sleep more comfortably on the bed, but they also become more sensitive and need even softer beds or training equipment. Cf. J. L. Nancy: Destruktion als Erinnerung der Struktion oder Techné.

fig. 3 a-c: above: Screenshots from video »Quest 2 Setting Up Guardian«; below: Karin Sander: Virtual Reality Visit, 2018, installation view: Karin Sander, Kunst Museum Winterthur

The latter example shows how the establishment of a double ground can vary. Spatial recognition is present in all technologies of virtuality, whether through indexical recognition, which uses lasers to create a complex and detailed 3D model, through surface recognition, using position determination and contrast ratios, or through the manual setup of a virtual space in a specific room. Even the most rudimentary VR is based on the perception of the surroundings. One argument for this is the manual setup process for VR headsets, which is the alignment of the floor level in the virtual space with the floor level in the external space. To do this, the actual floor has to be touched with the controller (fig. 3a), which adjusts the floor level in VR to that of the outside space. This double floor or double ground reduces the surrounding space to a flat plane (fig. 3b), but even here a contact between the levels remains – triggered by touch. However, newer headsets scan a more complex relief of the surroundings, similar to AR.

1.2 The Three Aspects of the *Areal Space*

Based on these considerations, the condition of the possibility of XR is not the superimposition of digital objects onto the actual surroundings or the creation of a comprehensive virtual world. Instead, it is primarily the alignment of a spatial model in situ and in real time. Therefore, AR and VR do not necessarily have to be interactive, but from a technical perspective, spatial perception must interact with spatial projection.

Generally speaking, it is about the collision of perception and projection, i.e. how the surroundings are perceived by the technology and how the technology then projects something onto the surroundings. Only a perception or projection through technology alone is never decisive and the interplay of realities takes place between them, whether visible or invisible. The concept of *areal space* is a way of describing a specificity of XR to set them apart from other technologies such as computer games, spatial projections or panoramas. It is a cumulative definition with three aspects, and when all three occur together, one can speak comprehensively of AR, VR, or MR. Hence, the *areal space* also allows to identify (historical) relatives that might only share one or two aspects of it. Even so, it can be useful for a deeper analysis of the latest technology.

The first aspect is that there must be projective and perceptive elements for XR. This is crucial as it results in two opposing directions. On the one hand, data is received from the surroundings and, on the other hand, data is projected from the data storage (fig. 4a). Due to the different directions and

sources, their encounter initially leads to collision, creating contradictions and conflicts. This condition is necessary but as a single feature not tied to digital technologies, as it touches on both machine vision techniques and classical theories of human perception.[15] Mirrors, glass panes and projectors can also be used to implement perceptive and projective elements. For example, the phantasmagoria (fig. 4b). In *Peppers Ghost* the reception of the stage collides with the projection of a figure underneath the stage on a glass pane.[16] Heterogeneous logics collide, and their differences are part of the mixed experience, such as those between supernatural and physical bodies or digital and everyday objects. With the first aspect, it can be asked: what collides and in what intensity? For example, virtual worlds and living rooms collide in VR, and while the projective elements are encompassing, the perceived elements can be rudimentary. The collision explains why these technologies are frequently promised as new realities but are rather experienced as conflicts that reach to the point of motion sickness. Thus, the first aspect is that for XR there have to be perceptive and projective elements, which collide on an *interface of the areal space* (headset/screen/glass pane).

In order to get closer to the specific characteristics of XRs, the perceptive and projective elements must secondly be related to each other, i.e. the *double ground of areal space*.[17] This can be done manually or technically. Thus, the phantasmagoria already fulfills two aspects of *areal space*, as it is also a double floor that raises the ghost one level higher than it actually is. In XR, cameras and sensors perceive the immediate surroundings and create a 3D model of it – either flattened or finely modelled – in order to subsequently calculate this representation of the surroundings point by point with the represented surroundings. Only after establishing a relationship, a double ground, it is possi-

15 See my considerations on Arthur Schopenhauer's receptive-projective theory of perception in Manuel van der Veen (2022): »Zur Technik-Ästhetik der Mixed Reality. Über das Verhältnis von Redundanz und Augmentation«, in: Lars C. Grabbe/Oliver Ruf (eds.), Technik-Ästhetik. Zur materialen und rezeptiven Systematisierung techno-ästhetischer Realität, Bielefeld: transcript, pp. 203–222, https://doi.org/10.14361/9783839456361-011.

16 Cf. Noam M. Elcott (2016): »The Phantasmagoric Dispositif. An Assembly of Bodies and Images in Real Time and Space«, in: Grey Room 62, pp. 43–71.

17 Therefore, we have to talk about the resulting images as adaptive ones. See Matthias Bruhn/Kathrin Friedrich/Moritz Queisner (2021): »Adaptive Images. Challenges for Visual Studies and Media Theory«, in: International Journal for Digital Art History 1, pp. 140–53, doi.org/10.11588/dah.2021.E1.83933.

ble to superimpose a virtual world onto the surroundings or embed individual digital objects within it. Therefore, the second aspect allows to ask: How is the relationship constituted? Is the spatial model detailed or abstract? Are differences provoked or is the aim to achieve convergence?

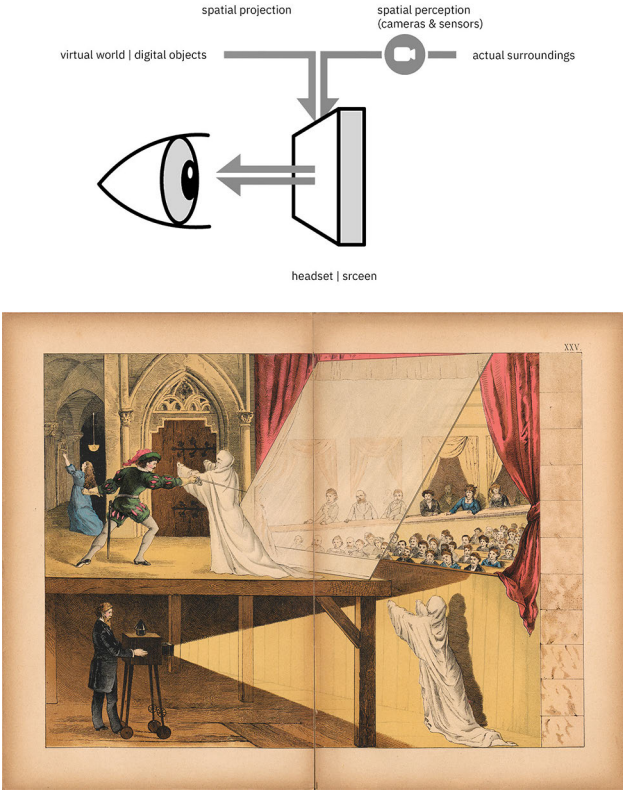

fig. 4 a&b: above: illustration of the processes and components making up XR (modified by the author); below: Illustration of Pepper's Ghost from Die Physik in Bildern, color plate XXV

The mobility of the areal space is the third aspect, since the double ground is not manifest and the anchoring is only valid for a certain period of time until

the *areal space* is carried away.[18] The digital model of the surroundings must be technically created and constantly updated for its mobility. The »uncertainty«[19] of this connection arises from the change of the surroundings and the position of the device within them, i.e. from the simultaneous localisation and mapping (SLAM). After all, the headset/screen needs a map for localisation, and in order to create a map, it has to localise itself. Since both the headset and the actual objects in the surroundings are in motion, this world modelling generates probability values and thus a constantly »fragmentary model«[20]. *Areal space* is where the device is carried to, where the gaze and the sensors are directed to, and it extends as far as they reach. Although it can be defined as an unreal place, it is not independent of a physical place. The third aspect therefore raises the question of how mobile the *areal space* is and shows why contemporary artists can use VR not only as a portal to unfamiliar worlds, but also to create site-specific works.

The three aspects were derived from the essential components of XRs: 1. the device (headset/screen/glass pane), 2. its relation to the surroundings, and 3. the interdependence between the two. These aspects define the foundation of the *areal space*, which takes place before it is occupied by projected objects or entire virtual worlds. Therefore, these aspects are also suitable for distinguishing between different XRs, so that various works of contemporary art can now be considered.

2. The *Areal Space* of Art with VR

The *areal space* is occasionally addressed directly within VRs, as in *Blooming Love* (2021) by Daniel Hengst. In this VR, the viewers find themselves in the middle of a bog, where new plants are constantly being generated and slowly passing

18 Regarding the mobility of AR see Nanna Verhoeff (2012): Mobile Screens. The Visual Regime of Navigation, Amsterdam: University Press, online: https://www.jstor.org/stable/j.ctt46mtwb (last access: 18.10.2025).

19 Florian Sprenger speaks of uncertain environments in connection with adaptive technologies that must be able to move automatically in their environment. Although a headset must be able to orient itself in the environment, movement remains the responsibility of the user. See Florian Sprenger (2019): Epistemologien des Umgebens. Zur Geschichte, Ökologie und Biopolitik künstlicher *environments*, Bielefeld: transcript, pp. 484–486.

20 Ibid.

by. For the experience, Daniel Hengst raises the virtual floor level so high that the viewer is stuck up to the neck in the bog. Raising the floor level creates a noticeable gap between the digital space and the exhibition space. In the work *Blooming Love*, the double floor becomes visible as it falls apart. Furthermore, there are several current VR experiences that also reflect the *areal space* in the exhibition. Therefore, the exhibited installations adhere the following pattern: a specific area in the exhibition is marked with lines, a platform, a carpet, soil, etc., where the VR experience then takes place. What is striking here is how the double ground repeatedly negotiates the difference between limited space and extended space.[21] Hence, a simple white platform, placed slightly elevated, can be set up to show a complete virtual exhibition, as in Karin Sander's exhibition *Karin Sander* (fig. 2c). In the following, two exhibitions that explore the double ground are examined: Sander's exhibition and *Drifting, Browsing, Cruising* by Polyviou and Elia. Both address the specificity of the *areal space* while different spatial models collide. These embrace drawing and architecture.

2.1 Real Time and Real Scale Floor Plans

In the following, the two spaces – the space of a drawing and the built space – are the focus of attention. Firstly, because AR and VR generally blur the distinction between 2D and 3D. Secondly, because drawing a space is a fundamental part of VR, as the Guardian example shows (fig. 3b). And finally, because the difference between the spaces highlights the collision and the conflicts it causes. In the anthology *Bildhafte Räume, begehbare Bilder* Kassandra Nakas and Philipp Reinfeld focus on the discrepancy that has existed since the Renaissance between two-dimensional architectural drafts and three-dimensional built spaces. Instead of nourishing this discrepancy, the various contributions consider draft and construction together in order to »examine real-time and real-scale design in VR.«[22] In this regard, Jan Philipp Drude refers to the cathe-

21 In research, attempts are being made, for example, to enable people to truly walk through an infinite virtual space by means of redirected walking, which involves walking along curves in real space. See Frank Steinicke et al. (2010): »Estimation of Detection Thresholds for Redirected Walking Techniques«, in: IEEE Transactions on Visualization and Computer Graphics 16/1, pp. 17–27, here: p. 25, https://doi.org/10.30965/9783846767238.

22 Kassandra Nakas/Philipp Reinfeld (2022): »Bildhafte Räume und begehbare Bilder. Zur Einführung«, in: Id. (eds.), Bildhafte Räume, begehbare Bilder, Leiden: Brill/Fink, pp. 1–7, here: p. 1, https://doi.org/10.30965/9783846767238, translation by author.

dral construction site around 1200: »Drawings on a scale of one to one were scratched directly into the floors and walls of the cathedral construction site, as can be seen, for example, in the tracing floor [*Rissboden*] of York Minster.«[23] Drawing the floor plan on site creates a parallel to the Guardian, which consists of ›walls‹ built from lines on the double floor. This parallel highlights the heterogeneous logics implemented within the technology and its historical connections. However, this connection goes even further: it places VR between draft and built space, emphasises it as a technology of scaling and demonstrates its potential as a site-specific medium.

Karin Sander, *Karin Sander*, 2018

Of course, double floors also exist in the field of art, without relying on XR. For this it could be referred to Karin Sander's work *Floor (Boden)* in the 2018 exhibition *Karin Sander* at the Kunstmuseum Winterthur (fig. 5a). The floating reality of the floor makes the viewer's steps cautious and the surrounding emptiness swaying. The viewer's attention is thereby divided between the unknown of a protruding platform and the all-too-familiar accessible plane. Standing on the raised floor, they are aware that this is not everyday life. The artist thus declares the museum space to be an artificial space, emphasised by the elevated stage.

To examine more closely how Sander connects different spaces with her works, the exhibition structure must first be briefly presented here on the basis of the floor plan (fig. 5c). Sander shows various series of works in her exhibition, which are separated by small rooms. As can be seen in the floor plan, the separate rooms are connected transversely by the work *Floor (Boden)* (the blue lines in fig. 5c) and longitudinally by a partially constructed brick wall (red lines in fig. 5c, visible in fig. 5b). Furthermore, the whole exhibition is framed by an outline consisting of Sander's *Kitchen Pieces* (red and blue dots in fig. 5c, on the left wall in fig. 5b). This arrangement is crucial because it takes place in two different exhibitions, one in physical space (blue elements) and one in VR (red elements). Sander places the VR exhibition *Virtual Reality Visit* in the museum, for which the entire annex of the museum was recreated in high resolution. Consequently, she was able to curate two exhibitions. However, the museum's annex was not simply adopted but rebuilt for VR. The first modification involves replacing the double floor of *Floor (Boden)* with that of VR. Just

23 Jan Philipp Drude (2022): »Vom Reißbrett in die Virtuelle Realität: Wie sich unsere Entwurfsperspektive verändert«, in: K. Nakas/P. Reinfeld: Bildhafte Räume, begehbare Bilder, pp. 11–26, here: p. 12, translation by author.

as *Floor (Boden)* connects the individual rooms, VR connects the digital model with the exhibition space. In fact, the relation between the two exhibitions is structured both by a separation and by a connection. On the one hand, Sander had the dividing walls of the exhibition space between the rooms 12, 13 and 14 removed in VR to underscore the connecting outline of the *Kitchen Pieces* (fig. 5b). On the other hand, a separation is inserted into the exhibition space, as the bricks from the ›removed‹ walls now block the passage in the digital space that *Floor (Boden)* had just bridged in the exhibition space. In the exhibitions, two double floors are laid, negotiating the relationship between separation and connection.

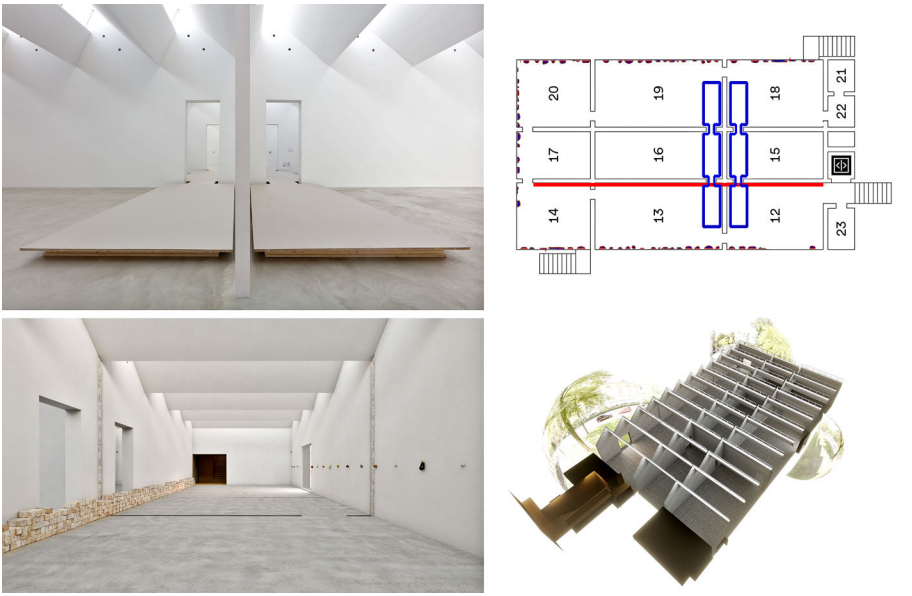

fig.5 a-d: tl: Karin Sander: Floor (Boden), 2018, exhibition view: Karin Sander, Kunst Museum Winterthur; bl: VR view of Karin Sander: Virtual Reality Visit, Kunst Museum Winterthur with virtually removed walls, 2018, virtual reality technic, 3-D visualization; tr: floorplan of the exhibition; br: 3D model of Karin Sander's VR exhibition: Virtual Reality Visit

The entanglements between the different spaces thus become crucial. In the VR exhibition space, for example, there is a centre that cannot be entered

(room 15 and 16). A circumstance that, on the representational level, repeats the characteristic of VR of being equally inaccessible from the outside. Moreover, in VR, the *Kitchen Pieces* create an outline, a specific area that surrounds the viewers. An area that is physically separated from the outside world in the exhibition space, as Sander blocks the view through the windows with large paintings, which are called *Patina Pictures (Gebrauchsbilder)*, in order to create a hermetically sealed exhibition space. This enclosed space is then reopened in the digital model by using 360° photographs of the outside space mapped onto spheres (fig. 5d).

The 3D model of the space in VR usually remains invisible. In this case, however, the transparency of the model breaks through the walls of the spatially structured architecture, and the intended hermetic nature of the exhibition is reopened in VR. This clearly shows how the artist has already anticipated the VR exhibition within the exhibition in physical space. Sander thus simultaneously negotiates the isolation of the museum and its architectural requirements for an exhibition with a specific feature of hermetic VR. A specific feature that directly addresses the everyday use of VR, as the Quest 2 tutorial states: »First, let's find a play area in a well-lit room and clear as much space as possible. Remove any obstacles which you might collide with while you're in your virtual environment.«[24] In Sander's work, the emptiness of a white cube[25] appears in analogy to the cleared-out area of VR, which is demarcated by the Guardian. VR is therefore not just about replacing reality with a virtual world. Rather, VR has an impact on reality. After all, like the grid-like floor level, reality must provide a smooth, resistance-free, and bare surface – this is an actual reduction of reality. Consequently, the physical space must be truly modified for the sake of VR, as it can only be projected where the surroundings have been cleared.[26]

Conversely, Sander's confrontation makes the White Cube appear as a projection surface for hermetic worlds. She clears away entire walls of the existing architecture in the process. As a result of clearing the space, lines are exposed

24 Meta Quest (2021): »Quest 2 Setting Up Guardian«, in: youtube.com. Online: https://www.youtube.com/watch?v=GojevL05Avw, 00:00:27 (last access: 09.12.2025).

25 Cf. Brian O'Doherty (1986 [1976]): Inside the White Cube. The Ideology of the Gallery Space, Santa Monica/San Francisco: The Lapis Press.

26 This is reminiscent of the long and empty corridor of central perspective. See Joseph Masheck (1991): »Alberti's ›Window‹. Art-Historiographic Notes on an Antimodernist Misprision«, in: Art Journal 50/1, pp. 35–41, here: p. 36.

on the ground at the same time. The tearing down of the partition walls reveals the floor plan, because lines can now be seen on the floor, as they are already marked on the floor plan. With the double ground, Sander emphasises the possibility of re-construction, beyond a rigid replica, by placing VR between the draft and the final construction, between a drawing and a built space. In VR, Sander reverses the construction process, removes the resistance of the structuring architecture, and thus brings about the augmentation of reality together with its reduction. To pursue these questions further, the next example introduces another technique that, like the floor plan or tracing floor (*Rissboden*), connects different dimensions and is directly related to virtual worlds.

2.2 Magic Circles as ›Imaginable Architectural Devices‹

In addition to the floor plan, the magic circle is considered here, as it also involves marking an area on the floor with lines that create a space, in this case a supernatural one. Furthermore, the magic circle has a tradition as a concept in game studies and was also transferred to computer games. The latter transfer was made by Jesper Juul in his 2005 dissertation *Half-Real*.[27] This concept is therefore particularly suited to mediate between the tradition of virtual spaces and the latest technology. A magic circle is the demarcation of a physical area, usually by carving lines into the ground, thereby establishing the boundaries within which an exchange between this world and the other world can take place. While the act of drawing lines is directly parallel to the establishment of the *areal space* by the Guardian in VR, its function varies in magical, playful and virtual practices. Katie Salen and Eric Zimmermann state the following about the magic circle: »The term is used here as shorthand for the idea of a special place in time and space created by a game.… As a closed circle, the space it circumscribes is enclosed and separate from the real world.… In a very basic sense, the magic circle is where the game takes place«[28]. As long as someone

27 Cf. Jesper Juul (2005): Half-Real. Video Games between Real Rules and Fictional Worlds, Cambridge, MA/London: The MIT Press. The magic circle was already discussed in *Les rites de passage* by religious ethnologist Arnold van Gennep, and the idea of understanding a game by means of the magic circle goes back to Johann Huizinga's *Homo ludens*. Cf. Stephan Günzel (2010): »Der reine Raum des Spiels. Zur Kritik des Magic Circle«, in: Mathias Fuchs/Ernst Strouhal (eds.), Das Spiel und seine Grenzen. Passagen des Spiels II, Vienna: Springer, pp. 189–202, here: p. 196, https://doi.org/10.1007/978-3-7091-0085-1_12.

28 Here quoted after J. Juul: Half-Real, p. 164.

is inside this area, the rules of the game apply. Not every game has such clear demarcations as, for example, the field for the children's game of hopscotch (*Himmel und Hölle*). However, according to Juul, the boundary is even more distinct in a computer game, as it »only takes place on the screen«[29]. This makes the model particularly interesting in comparison to the *areal space* of VR.

Juul's motivation to use the magic circle for computer games was the attempt to reconcile the real elements of a game (the ludological category of rules) with the fictional ones (visual and narratological elements). The accompanying illustration (fig. 6d) can be summarised as follows: »The space of a game is part of the world in which it is played, but the space of a fiction is outside the world from which it is created.«[30] Stephan Günzel emphasises that Juul's magic circle no longer represents a boundary in the world, but rather reduplicates the boundary between fiction and reality outside the ›real world‹. Günzel further criticises that the rules in a computer game differ from the rules of a conventional game. After all, one cannot choose to abide by the rules of the computer game: »The game is simulated physics at every level – with the exception of the area that Juul calls fiction.«[31] Consequently, this argument has an impact on the permeability of the magic circle. There is only a transition from the fictional world to the game space, as the former can be used to anticipate the latter. The skyscraper and the plank in *Richie's Plank Experience*, for example, imply that one can probably jump. However, there is no way to leave the system of rules, the game space to immerse oneself in the fiction outside it. Thus, one cannot simply climb down the facade because that is not part of the prescribed interactions in *Richie's Plank Experience*. The magic circle is therefore not a suitable model for representing the relationships between real and fictional elements in computer games. The model also fails to highlight the specificity of computer games, as this specificity lies neither in the narrative (fiction) nor in the rules (reality), but rather – according to Günzel in his text *Der reine Raum des Spiels* – in the fact that »its reception [that of computer games] does not require any external reference, but is based solely on action relying on spatial structures. […] Contrary to Juul, it can be said that computer games can be distinguished from all other types of games precisely by the absence of a magic circle.«[32]

29 Ibid., p. 165.

30 Ibid., p. 164.

31 S. Günzel: Der reine Raum des Spiels, p. 200, translation by author.

32 Ibid., p. 200f., translation by author.

But what about the magic circle when it relates to VR? After all, the ›fictional world‹ is not projected onto the outside of the ›real world‹, but rather superimposed on it. As a result, it could be asked: Does the simulated physics overlap with the real physics? Can they influence each other? Even if there is no escape from simulated physics in VR either, the concept of the magic circle from game studies still raises questions that can be used to further differentiate the area of the virtual.

Theodoulos Polyviou and Eleni Diana Elia, *Drifting, Browsing, Cruising*, 2021

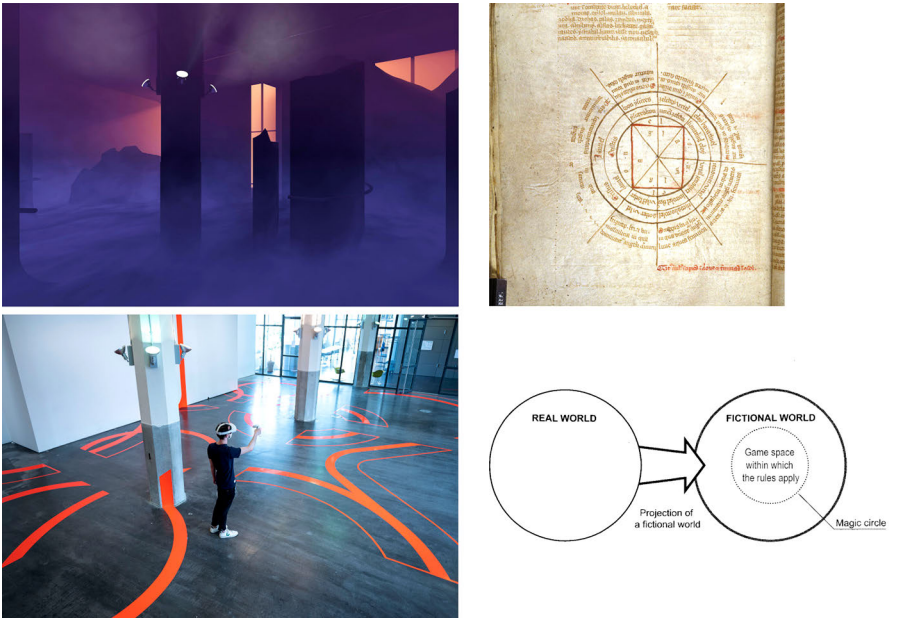

fig. 6 a-d: tl: Theodoulos Polyviou and Eleni Diana Elia: Drifting, Browsing, Cruising, 2021, ZKM Karlsruhe, VR view; bl: installation view; tr: diagram of magic circles for the conjurations of airy spirits; br: Jesper Juul's diagram of the magic circle for computer games (modified by the author)

Drifting, Browsing, Cruising by Polyviou and Elia was on display at the ZKM in Karlsruhe in 2021. Instead of emptying a full room as Sander did, an empty room is virtually filled up with obstacles here. A floor plan consisting of thick

orange lines, is therefore not derived from the existing architecture, but added to it. Subsequently, the brightly glowing lines on the floor of the exhibition are erected in VR as impenetrable ruin walls. In this respect, the artwork produces a categorical transformation from a mundane exhibition space to a sacred ambience. While the exhibition space allows for an overview due to its emptiness and clear markings, the projected space is of unpredictable density. In the VR, diffuse light falls on purple mist, while columns, struts, railings and walls create resistance as almost black surfaces and block lines of sight. In contrast to the exhibition space, it is difficult to orientate oneself in the digital mist.

Polyviou and Elia's work opens up institution-critical perspectives[33] and addresses various modes of encounter in digital, physical and virtual space. The encounter between different entities, the lines on the ground and the virtually augmented architecture should be interpreted here beyond the floor plan via the supernatural magic circle. Polyviou refers directly to the considerations of the historian of religion Andrea Franchetto. He describes the magic circle as an »imaginable architectural device«[34] through which ritual elements are expressed in architectural objects. For this purpose, the drawing is scratched into the ground, forming the floor plan of a cosmological topography (fig. 6c). This creates a paradoxical space in which two areas communicate because the imagined boundaries are materialised.

> »In other terms, the lines on the ground become material anchors that substantiate the presence of the internal image boundaries. [A] blended space, which is the fusion of the mental and the material domain. It is thus augmented materiality – spaces ›called up‹ in order to actualize a new set of desires and power relations […]«[35]

The drawing is architectural because the lines are protective walls – they enclose, demarcate and provide orientation for the control of space as well as for the movement of practitioners. The dramatic effect of a magic circle consists

33 Cf. Annette Urban (2023): »Virtual Spaces for Transformative Encounters and Vast Reciprocity – An Interview with Theodoulos Polyviou and Jazmina Figueroa«, in: Lívia Nolasco-Rózsás/Marianne Schädler (eds.), Beyond Matter, Within Space. Curatorial and Art Mediation Techniques on the Verge of Virtual Reality, Berlin: Hatje Cantz, pp. 429–443, here: p. 440.

34 Cf. Andrea Franchetto (2020): »Imaginal Architectural Devices and the Ritual Space of Medieval Necromancy«, in: Endeavour 44/4, pp. 1–16.

35 Ibid., p. 6.

in the fact that it is not allowed to have its lines broken, otherwise the different dimensions would merge outside the demarcated area. Polyviou and Elia's circles are interrupted many times. After all, the aim is to provoke an encounter between different spheres and people.

In order to position the magic circle of the Middle Ages, computer games, and VR in relation to each other, certain shifts must be highlighted. Firstly, it is crucial to note that the literal demarcation of an area rarely applies to games in general and does not apply to computer games at all. In the set-up of VR, however, this very process is repeated: an area is marked as a drawing in which the virtual world takes place, and if this area is crossed by the user, the virtual world dissolves. However, since the boundary is only drawn in VR, its status is at least problematic.

Secondly, it is therefore important that the conventional magic circle may establish multiple boundaries: an inner circle that protects the magicians and an outer circle in which the supernatural beings appear and are held captive. It is this variety of boundaries that is also addressed in contemporary art with VR. Some protect users and others exclude people outside of VR. And then there are those that even include outsiders to a certain extent in the *areal space*, although they are not wearing a headset. Even if, contrary to Juul's illustration, fiction in VR is projected directly onto reality, the two do not automatically overlap. When a person enters the area marked by Polyviou and Elia in the exhibition space, they are not part of the VR but they enter the *areal space*. The person wearing the headset cannot see these ›intruders,‹ however, they influence the experience by infiltrating the cleared area. VR is also not completely hidden from outsiders, as they can observe how the person wearing the headset respects and avoids the virtual boundaries. So, as with the magic circle, it does matter whether one is inside the *areal space* or not.

The third point concerns the rules of the game, which, according to Günzel, appear as simulated physics in computer games. One cannot act against the simulated physics in VR either. However, since one's own body is involved in VR and the simulated physics overlap with the real ones, there is room for maneuver (*Spielraum*) in which a kind of creative waywardness (*Eigensinn)* is possible. This means that the users can perform gestures that the developers could not have foreseen. They can try to lean out of the world, exploit dislocations between the model and the surroundings as well as break through collision boxes that apply to the avatars but not to their own bodies.

The magic circle emphasises the interplay between imagination and physics, which is becoming increasingly relevant for the exploration of con-

temporary virtual art. Even though simulated physics cannot be violated in a virtual world, the *areal space* opens up a »system of relations between different elements that can be found in society, and which strategically manipulates power and knowledge in order to orient, direct, and control those elements.«[36] The *areal space* is a structured space that also has a structuring effect on the actual surroundings outside of VR.

Conclusion

This chapter presented the *areal space* as an overarching concept for interpreting XRs. The concept identifies the technical specificity of the procedures – to be both space-perceiving and space-projecting – beyond ontological dichotomies such as ›virtual‹ versus ›real‹. Therefore, this concept can be used to differentiate more precisely between the technologies of VR, AR, and MR, as well as between different VRs. Regarding the first aspect of the *areal space*, i.e. the interface, it can be said that in Sander's VR, a full and structured space is perceived, and an empty one is projected, while both remain comparable due to their similarities. However, there is no direct collision, as the two exhibitions are experienced independently of each other: one on foot and one via controllers. In contrast, Polyviou and Elia's VR builds on strong visual differences to the exhibition space, where the perceived and projected space provokes actual collisions due to their superimposition.

In relation to the double floor, it is crucial that in Sander's VR, the existing space calls for an onsite renovation in VR, which reveals the drawing of the floor plan. *Drifting, Browsing, Cruising*, instead, was presented as a space in VR that causes a drawing in the exhibition space. This inversion shows how the effects of the double floor can occur in both directions. Nevertheless, in both works discussed, the double floor creates a site-specific area by superimposing the critique of the exhibition space onto its usage. Once through its modification and once through its sacralisation. Yet, the double floor does not necessarily result in site specificity; as in *Richie's Plank Experience*, it can also intensify the affective experience, or, as in Daniel Hengst's VR, mark the distance between worlds, or simply define the field of experience. Of course, there are also VRs, which, apart from the technically necessary spatial references, continue to focus on the hermeticism of new worlds.

36 Ibid., p. 4.

Furthermore, it could be mentioned that despite the fact that Sander's VR and Polyviou and Elia's VR are site-specific, the mobility of the *areal space* varies significantly. This is because the model in Sander's VR is exclusively tied to a specific exhibition. *Drifting, Browsing, Cruising*, by contrast, is more mobile, as the orange line, i.e. the imaginable architecture, can also be placed in a different location and because the entire digital space is already accessible as a detached online experience, which adds another layer to the double ground.[37]

Finally, alongside the potential for differentiation, it is the theoretical scope of the concept of *areal space* – its theoretical compatibility, not least for art historical questions – that may be of interest to XR research. The aforementioned floor plan or tracing floor (*Rissboden*) supplemented the concept with the tensions between 2D and 3D, draft and built space, which are also fundamental to XR. In the same way, the ›imaginable architectural device‹ extended the spatial projection and the spatial perception of the *areal space* into a relationship between imagination and materialisation. The drawing ties the imaginable to a physical space and VR back to the magical origins, on which AR is based: the magic lantern and the phantasmagoria. The virtual thus refers to a dimension of the ghostly and spiritual, which would be lost under a solely computer-technical classification. However, the comparison that the floor plan and the magic circle open up between everyday life, computer games, VR, and art, could not be played out here exhaustively. Rather, the aim was to show how technical, (art-)historical and theoretical considerations converge through the concept of *areal space* in order to approach VR as a virtual phenomenon.

Bibliography

Boehm, Gottfried (2012): »Der Grund. Über das ikonische Kontinuum«, in: Id./Matteo Burioni (eds.), Der Grund. Das Feld des Sichtbaren, Munich: Wilhelm Fink Verlag, p. 29–91.

Bruhn, Matthias/Kathrin Friedrich/Moritz Queisner (2021): »Adaptive Images. Challenges for Visual Studies and Media Theory«, in:

37 See the online version of *Drifting, Browsing, Cruising*, which was subsequently made available for further exhibitions as *fantastic confabulations*, »an online platform for virtual, yet spatial exhibitions based on architectural motifs of the building, currently occupied by ZKM | Karlsruhe«, online: https://fantastic-confabulations.beyondmatter.eu/drifting-browsing-cruising/index.html (last access: 17.11.2025).

International Journal for Digital Art History 1, pp. 140–53. DOI: doi.org/10.11588/dah.2021.E1.83933

Chalmers, David J. (2022): Reality+. Virtual Worlds and the Problems of Philosophy, New York: W. W. Norton & Company.

Dresscher, Paulien/Nanna Verhoeff (2020): »XR. Crossing and Interfering Artistic Media Spaces«, in: Larissa Hjorth/Adriana de Souza e Silva/Klare Lanson (eds.), The Routledge Companion to Mobile Media Art, New York: Routledge, pp. 482–92.

Drude, Jan Philipp (2022): »Vom Reißbrett in die Virtuelle Realität: Wie sich unsere Entwurfsperspektive verändert«, in: Kassandra Nakas/Philipp Reinfeld (eds.), Bildhafte Räume, begehbare Bilder, Leiden: Brill/Fink, pp. 11–26.

Elcott, Noam M. (2016): »The Phantasmagoric Dispositif. An Assembly of Bodies and Images in Real Time and Space«, in: Grey Room 62, pp. 43–71.

Franchetto, Andrea (2020): »Imaginal Architectural Devices and the Ritual Space of Medieval Necromancy«, in: Endeavour 44/4, pp. 1–16.

Günzel, Stephan (2010): »Der reine Raum des Spiels. Zur Kritik des Magic Circle«, in: Mathias Fuchs/Ernst Strouhal (eds.), Das Spiel und seine Grenzen. Passagen des Spiels II, Vienna: Springer, pp. 189–202. DOI: https://doi.org/10.1007/978-3-7091-0085-1_12

Juul, Jesper (2005): Half-Real. Video Games between Real Rules and Fictional Worlds, Cambridge, MA/London: The MIT Press.

Masheck, Joseph (1991): »Alberti's ›Window‹. Art-Historiographic Notes on an Antimodernist Misprision«, in: Art Journal 50/1, pp. 35–41.

Meta Quest (2021): »Quest 2 Setting Up Guardian«, in: youtube.com. Online: https://www.youtube.com/watch?v=GojevL05Avw (last access: 09.12.2025).

Milgram, Paul/Fumio Kishino (1994): »A Taxonomy of Mixed Reality Visual Displays«, in: IEICE Transactions on Information and Systems E77-D/12, pp. 1321–1329.

Nakas, Kassandra/Philipp Reinfeld (2022): »Bildhafte Räume und begehbare Bilder. Zur Einführung«, in: Id. (eds.), Bildhafte Räume, begehbare Bilder, Leiden: Brill/Fink, pp. 1–7. DOI: https://doi.org/10.30965/9783846767238

Nancy, Jean-Luc (2003 [1992]): Corpus. New York: Fordham University Press.

Nancy, Jean-Luc (2008): »Destruktion als Erinnerung der Struktion oder Techné«, in: https://ifm.rub.de (27.11.2008). Online: https://ifm.rub.de/2008/11/1012-jean-luc-nancy-zu-gast-im-bkm/ (last access: 10.10.2025).

Nancy, Jean-Luc (2013): »The Technique of the Present«, in: Documents of Contemporary Art 4/2013, pp. 104–115.

O'Doherty, Brian (1986 [1976]): Inside the White Cube. The Ideology of the Gallery Space, Santa Monica/San Francisco: The Lapis Press.

Reich, Julia/Annette Urban/Manuel van der Veen (2023): »passthrough. Von Portalen, Durchblicken und Übergängen zwischen den (virtuellen) Welten«, in: Kunstforum International 290, pp. 86–95.

Skarbez, Richard/Mary C. Whitton/Missie Smith (2021): »Revisiting Milgram and Kishino's Reality-Virtuality Continuum«, in: Frontiers in Virtual Reality 2, n.p.

Sprenger, Florian (2019): Epistemologien des Umgebens. Zur Geschichte, Ökologie und Biopolitik künstlicher *environments*, Bielefeld: transcript.

Steinicke, Frank et al. (2010): »Estimation of Detection Thresholds for Redirected Walking Techniques«, in: IEEE Transactions on Visualization and Computer Graphics 16/1, pp. 17–27.

Urban, Annette (2023): »Virtual Spaces for Transformative Encounters and Vast Reciprocity – An Interview with Theodoulos Polyviou and Jazmina Figueroa«, in: Lívia Nolasco-Rózsás/Marianne Schädler (eds.), Beyond Matter, Within Space. Curatorial and Art Mediation Techniques on the Verge of Virtual Reality, Berlin: Hatje Cantz, pp. 429–443.

van der Veen, Manuel (2022): »Zur Technik-Ästhetik der Mixed Reality. Über das Verhältnis von Redundanz und Augmentation«, in: Lars C. Grabbe/Oliver Ruf (eds.), Technik-Ästhetik. Zur materialen und rezeptiven Systematisierung techno-ästhetischer Realität, Bielefeld: transcript, pp. 203–222. DOI: https://doi.org/10.14361/9783839456361-011

van der Veen, Manuel (2025): Augmented Reality, Leiden: Brill/Fink. DOI: https://doi.org/10.30965/9783846769409

Verhoeff, Nanna (2012): Mobile Screens. The Visual Regime of Navigation, Amsterdam: University Press, online: https://www.jstor.org/stable/j.ctt46mtwb (last access: 18.10.2025).

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