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Oblivious to Gravity: Virtual Architecture between disciplinary dead ends and complex intersections

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Abstract

Design media have an intimate relationship with architecture, and also serve as the means of its practice. With new technologies, and especially virtual reality, a new rhetoric of design media is becoming increasingly possible. That is, media being used as means both to design and to experience space. Such rhetorics expand the formal manifestations of architecture besides building, as well as the horizon of what can be design as well as what can be aesthetically experienced as architecture.

This research is concerned with the topic of 'Virtual Architecture.' That is architecture specific to the virtual domain that is experienceable, however unbuildable. As an alternative mode of computational design, Virtual Architecture is concerned with a latent domain of architectural experience that is not attainable through traditional practices of building but only accessible through the virtual dimension, and as such its design is not restricted by the concrete physical world.

The aim of the paper is to construct the research foundations for 'Virtual Architecture,' through the assembly of knowledges from multiple epistemic domains. It sets off by highlighting disciplinary limitations and challenges as well as the potentials of transdisciplinary practice that are central to this research. It proceeds by reviewing relevant literature domains and precedents from architecture and game studies, identifying and examining their limitations. Furthermore, it describes practical constraints in the design-investigation of media-specific virtual environments which require a shift of paradigm in design media. More specifically, that is the replacement of the Cartesian-Euclidean understanding of space to the spatiotemporal model of Riemannian non-Euclidean geometry that treats 'space' as a variability. Lastly, it describes how design knowledge can contribute in experimental studies of virtual environments for the investigation space-related aesthetics capacities.

Keywords

Virtual architecture; Virtual reality; Design media; Aesthetics; Computational design.

Note

The title "*Oblivious to Gravity*" is a reference to the building-sound-compositions series of composer and sound artist Gerriet K. Sharma. See {kA}: keine Ahnung von Schwerkraft (2010-2015).

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Architecture has a close relationship with design media. In the past few decades digital design media have replaced the analogue drawing board as the means of architectural practice. Design media also became part of the discipline's discourse as well as objects of research and development. However, beyond their conception and implementation as tools of practice lies the potential of such media to produce and materialize themselves experienceable space without the necessity for built form. Not only that, but contemporary media like virtual reality (VR) can produce spatial environments that are fundamentally unbuildable, yet experienceable. Thus, in the context of architecture a new rhetoric of design media is becoming increasingly possible: media being used as means both to design and to experience space. Besides expanding the formal manifestations of architecture beyond building, this use of media also expands the horizon of what can be designed and what can be aesthetically experienced, while serving as a more immediate means for architecture than building.

This essay is concerned with the topic of Virtual Architecture. With architecture as a starting point it sets out to draw affinities with other epistemic domains that overlap the subject. It proceeds to integrate knowledges and practices from these different disciplines, constructing the topic in the in-between area of their separation.

Introduction: Discipline & Potential

Firmitas, Utilitas, Venustas
Architecture is the art of building
Architecture or revolution
Everything is architecture

Aphorisms, like the ones above, often deprived of their authors, and out of both historical and textual context, are examples of values instilled in the architectural habitus. Besides the need of guiding definitions, what they also demonstrate is that the question of 'what architecture is' is rather impossible to answer, also perhaps a futile one. A more promising question would be 'what can architecture do.' However, to ask such a question of a discipline that is insistent to its tradition and furthermore centered around the practice of its protected profession, will inevitably be articulated in terms of its past. Thus, it can only yield answers as functions of its own heritage, the history, means and conventions related to the profession's practice.

Like deep roots, such conventions pull the conception of architecture to the immanence of its past. They operate as condensers, quasi-definitions of its relevance, to fall back to when tackling wicked questions of defining a field and its relevance. They form a certain center, in Derrida's terms (1993), the purpose of which is to organize and demarcate the field as well as to limit free-play within it. In other words, such abstract signifiers serve as a reference to keep a field together by limiting its historical evolution to linear progress.

Questioning that model, Wark asks what architecture is while introducing an undeniable rupture:

> All the architecture that we know of is architecture of the Holocene. (Wark, 2017)

Bypassing historical time Wark points to a geological 'event' as a means of drawing a line from all previous periods and their knowledge. What is to become of architecture when its primordial function to protect 'man' from the environment is challenged by the reversal of causal roles between

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'environment' and humanity? Affirming in that way a lack of precedents, Wark performs a gesture of asking for a more general and radical reconsideration of what architecture is, and therefore of what architecture can do.

Concerned with the unbuildable, the theme of Virtual Architecture questions core aspects of architecture's discipline. At the same time it does not belong to a single field but is rather constructed in the interweaving of multiple epistemic domains. Such a process Manning (2015) identifies as "research-creation:" a "transversal engagement with different disciplines, [that] incites a rethinking of how artistic practice reopens the question of what these disciplines […] can do." At the same time, Manning states, research-creations asks for new forms of evaluation and of valuation of the work we do.

Transdisciplinary research (TR), that this essay is concerned with, inquiries into disciplinary capacities. Questioning the rigid understanding of disciplined fields, it points to new ways of articulation between epistemic domains in order to generate new potentials. As Linder (2005) highlights, TR operates at disciplinary boundaries which is "also where we become most aware and in need of the tools, techniques and technologies of the discipline." It is thus not an abandonment of the discipline, but rather, an investigation of architecture's "undisciplined appearances" that are only expressed in states of 'transness.' Through a reconfigured practice, the aim of TR is to investigate and tame such appearances in order to uncover latent potentials.

Oblivious to Gravity: The case for Virtual Architecture

The focus of this essay is a particular facet of what architecture could do, that is, architecture specific to the virtual domain. For architecture as the epistemic field concerned with matters of experienceable space, the domain of the virtual offers an altogether new spatial substrate for exploration.

More precisely, it is concerned with what I would like to call inconstructible spaces. These are spaces that we humans are perfectly capable to experience, which however cannot be built in the physical world. What this statement implies is that there is a latent domain of experienceable spaces that cannot be addressed by a classical definition of architecture as the "art of building," as they can't exist in physical form and cannot be experienced as such. They can only exist and be experienced as virtual spaces. Consequently, this latent domain of spaces is analogous to an equally latent domain of spatial aesthetics. Therefore, a consideration of the set of experienceable post-physical-world spaces extends the horizon of what architecture can do. On the one hand, it extends what architecture can do as design knowledge pertaining to the design and study of spaces. On the other, it extends what architecture can do as affect, in the sense of the aesthetic experience it evokes.

The spaces particular to this research have to do with epistemological assumptions of architecture and design related to the theoretical and practical understanding of space. The working title "Oblivious to Gravity" is a twofold reference to this premise, both critical and speculative. As critique, it is concerned with the wider design discipline, which deeply rooted in their traditions and conventions, adheres to a working approximation of physical space as absolute. That is the space described by Newton in the 17th century and instrumentalized through a Cartesian model of Euclidean geometry. Contemporary design software, relying on an obsolete definition of physical space are thus, by and large oblivious to the macro-structure of space and the nature of the phenomenon of gravity as described by modern physics. That is to say that spatial design disregards the science behind the

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phenomenon it models[1].

As speculation, and in the context of architecture and design, this study is concerned with the replacement of the Newtonian-Euclidean understanding and model of space with a relativistic one. Its purpose is not to bring spatial design up-to-date with physics in order to better simulate the physical world, but rather to escape altogether the question of simulation as well as the visual prehension of space. The implications of carrying such a paradigm shift from mathematics and physics to spatial design are manifold. Chief among them for this context is that non-Euclidean geometry, the geometry behind Relativity Theory, allows for multiple spatial constitutions. Instead of taking space as a singular, uniform and flat entity, non-Euclidean geometry is concerned with a larger group of curved spaces. The speculative aspect of this premise lies in the induction of such properties in design practices as elements to design with. The adoption of a relativistic design framework as both a conceptual and practical tool, would enable design to experiment with and materialize experienceable architectural environments that are oblivious to the precise gravitational phenomena and shape of the concrete physical-world. The exploration of spatial configurations divergent from physical-reality is ultimately an exploration of what can be designed that is only constrained by its capacity to be experienced. It is thus, an exploration of spatial aesthetics and of the human capacity for spatial experience.

1. Design software available to architects (as well as game designers) adhere to a Cartesian model of Euclidean space, which are practically flat-earth simulations.

Virtual Architecture is therefore concerned with the shift from the design in space to the design of space. The use of design media in this context does not comply with their usual representational rhetoric, in which design takes place inside a provided simulation of space. Rather, this case utilizes media for their ability to create media-specific spaces themselves. This stance towards spatial media, that I have elsewhere called "choropoietic," (Miltiadis, 2019) is precisely an implementation in which their space-making properties are treated creatively[2]. The departure from Cartesian and absolute space to a plural relativistic model, opens up for research-through-design a new world of species of spaces.

2. Such implementation is currently limited, and can be even considered as counter-intuitive, since design software have their own spatial rhetoric when it comes to their use, which is locked inside the aforementioned scientifically obsolete paradigm. Therefore, a new logic and means of their use is required as a framework in order to maximize their affordances for space-making.

Disciplinary dead-ends

Aspects pertaining to Virtual Architecture have been investigated within different disciplinary domains. Such precedents, besides from architecture also from game studies and experience research, follow different tangents and carry different methodologies, agendas as well as capacities and limitations. The creation of a research area in-between different domains requires a consideration of these previous contributions as well as their disciplinary limitations.

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> If Serlio had written his eight books of architecture today, he probably would have added a ninth book on computers.(Bertol, 1994)

What we can call 'Virtual Architecture' is certainly not a new phenomenon. An archeology of former research can resurface sparse but important work. In the late 1980s, the first wave of investigations into virtual space heralded VR as a promising emergent technology[3]. Architects were among the first to take up on this new technology producing research as intersection of theory and design practice. However, only textual work survives today.

Throughout the 1990s multiple architects published work relevant to the investigation of architecture in the virtual domain. A landmark treatise on the subject was published in 1992 by Marcos Novak (1992) which still remains an important account of the expressive and aesthetic premises of Virtual Architecture. Other notable contributors of this period were Daniela Bertol, Monika Fleischmann and Wolfgang Strauss, Gerhard Schmitt's lab and Peter Anders. In addition, a small number of symposia and architectural magazines gathered important accounts on the matter[4].

Paradoxically, these sparse however crucial contributions and growing interest into virtual architecture appear to climax around the end of the 1990s and then vanish. A key issue that cut these efforts short was the untimeliness of technology that appears as a probable cause for this halt. As we now know, VR would require another decade to come to maturity and to reach democratic accessibility[5]. At the same time, the emergence of "parametric design" in the 2000s grew to become the leading paradigm for computational architecture[6]. Since then, the term 'digital architecture' came to point to the implementation of a loose set of computational approaches in design or fabrication processes of architectural designs that intend to be built. Similarly, the popularization of VR in the last years, has seen its recruitment for purposes such as visualization, evaluation and marketing of building designs.
Experimental works of architecture concerned with unbuilt forms, that have been a historical part of the discipline, are largely absent from the focus of computational architecture and its discourse. As a blanket term 'digital architecture' came to overshadow other rhetorics of use of design and computational media which do not concern building as their final form. That is not to say that architects are not concerned with such use of media, but rather that such speculative applications are mostly considered outside of the normative domain of computational architecture and its discourse[7].

3. See for example Jaron Lanier's design-investigations outlined in Kelly (1989); also the 1990 "Virtual Worlds - Artificial Realities" symposium, Ars Electronica archive.

4. See the "Architectural Design" issues on "Cyberspace" edited by Martin Pierce and Neil Spiller (1996; 1999), and "Hypersurface Architecture" by Stephen Perrella (1999; 1998). For examples of edited volumes on the topic see Sakamura and Suzuki (1997) as well as symposia publications by "V2_ Institute for the Unstable Media."

5. The revival of VR is largely attributed to the 2012 Oculus Rift crowdfunding campaign, that reignited market interest into VR technology.

6. As a more accessible means of computation than programming, technologically more timely and concerned with building production processes and their automation, parametric design was quickly adopted in architectural processes, integrated in design software, as well as in educational curricula and discourse.

7. Since the so-called 'paper architecture,' experimental works of architecture were often met with hostility or resistance (see Woods, 1992). However, as Young (2017) discusses in the context of speculative design, its impact for the field of architecture and its discourse has been instrumental.

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Nonetheless, in a timespan of almost a decade, the above archeology of precedents into virtual architecture managed to comprise a very rich body of work on the topic that can be said to have already marked an implicit tradition. The theoretical investigations of these pioneers maintained an optimistic and visionary attitude towards core aspects and the future of architecture. Among key topics discussed were matters of aesthetics, materiality, ideation as well as the Cartesian dualism embedded in spatial design. Contrary to popular belief that VR as a medium concerns the mind and leaves the body behind, for most of these investigations the body had a central role. The understanding of VR as highlighted in these writings was to explore the poetic potential of architecture in the virtual, intimately correlated to the exploration of the capacities and potentials of embodied experience[8]. While the viability of similar investigations within the domain of architecture is presently questionable, this corpus of work is still highly prescient.

8. Such concepts were further elaborated by feminist theorists such as Hayles (1999), Grosz (2001) and Gins and Arakawa (2002).

Game Studies

By the early 2000s, while architectural investigations in virtual space end, the videogame phenomenon came to the forefront as a champion across all entertainment media[9] and a contender for new form of literacy[10]. The field of game studies was then formalized as an interdisciplinary project devoted to the study of videogames, which has since grown to produce significant work on the new medium.

9. Since 2000 videogames has been gaining significant popularity and by the early 2010s the financial gains of the videogame industry surpassed that of the music and film industries.

10. Videogames have been discussed as a new kind and genre of literature, Zimmerman (2008); that is one of the most powerful elements of 'new media literacy,' Jenkins (2011), and to generate real knowledge Aarseth (2001a).

In the inaugural editorial article of the field's first academic journal, Espen Aarseth, a leading scholar in the field, pointed out:

> Computer games are perhaps the richest cultural genre we have yet seen, and this challenges our search for a suitable methodological approach. We all enter this field from somewhere else, from anthropology, sociology, narratology, semiotics, film studies, etc, and the political and ideological baggage we bring from our old field inevitably determines and motivates our approaches. (Aarseth, 2001b, emphasis in original)

As he highlights, the unprecedented videogame phenomenon leaves the question of methodology open. Therefore, game studies was constituted as a collective interdisciplinary effort open to scholars all coming from "somewhere else."

11. The examples of backgrounds given by Aarseth, a scholar originally of a literature background, betray the field's bias towards the humanities, which, for this particular inquiry becomes problematic.

12. Among influential analyses, Aarseth's (2001c) declared that "games celebrate their spatial representation as their central motif and raison d'etre." For further methodologically diverse examples see Stockburger (2007); Fernández-Vara et al. (2007); Wolf (1997); Jenkins (2004).

However, another event that marked the field was the shift towards matters of spatiality, which comes to question the particular understanding of interdisciplinarity.[11] Concurrently with tits foundation, a series of significant yet heterogeneous contributions claimed the centrality of space for videogames.[12] For Günzel (2010) who coined the "spatial turn in game studies" the matter of space in videogames called

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for a paradigm shift in their study. Though, regardless of the importance of these contributions the "turn" did not come to any closure or conclusion, neither did it give rise to new 'schools' or methodologies of inquiry within games studies. What is left from this period is a loose set of contributions highlighting partial aspects of videogame spatiality. In short, the question of space remained unanswered. The lack of methodologies within game studies, appropriate for the study of spatial matters, appears as a probable cause for this investigative gap.[13]

While the inclusion of architecture and design-research in such investigations is promising, game studies appears to block entry to methodologies foreign to the humanities. Design, Aarseth previously acknowledged, is "the only powerful nexus among these diverse approaches" able to bring together "humanists, technologists, and social scientists." However, he paradoxically rejected such a prospect on the grounds that "design theory" is underdeveloped.[14]

Closing the door to the potential of an alliance with design-research, game studies' design taboo is a position detrimental to the field's interests. While blocking design-research proper, game studies remains methodologically and epistemically limited to the first only of Frayling's tripartite model of "research in arts and design,"[15] associated with theoretical-textual research. This type of research has a particular blindspot, since videogames are not predominantly programmed or typed anymore. Videogames are predominantly designed. The exclusive study of videogames as playable finished objects[16] disregards a connotation of the videogame related to its understanding as a medium as well, that is intimately associated with designerly practices and designerly knowledges. As Stenros and Kultima point out[17] a significant capital of videogame knowledge related to their design and production lies in a tacit dimension. This knowledge is rather elusive to the current state of the game studies field, as it cannot be easily activated or accommodated through 'scholarly' methodologies and textual means of output.

Eventually, we can ask whether 'playing research' as the overruling methodology of investigation, alongside knowledge stemming from fields like philosophy, sociology, media studies, etc. and a word-processor are enough for the study of videogames. Concepts, ideas and knowledge that require a sketch, a drawing, or a 3D model to be communicated, even a game-prototype in our case, can suggest otherwise. That "making sense" of videogames through text, of a medium that reportedly deals with concepts and knowledge that surpass the model of textual narrative,[18] might miss the point. Eventually, the "spatial turn" as a paradigm shift entails a shift in methodology as well, instead of reciting previous traditions under a new theme.

In light of these issues, the missing part in videogame-related means of knowledge production appears to be what Frayling (1993) described

13 The epistemic backgrounds at the initial phase of the field were adequate and compatible its previous hypertextual and interactive considerations of videogames. However, the technological and cultural evolution of the videogame phenomenon that brought about the spatial paradigm underlined once again the question of suitable methodology.

14 What Aarseth (2005) calls "design theory" is questionable. His account confuses game design as a commercially applied practice with the wider design discipline associated with the rigorous tradition of design-research. Aarseth has been vocal about his distrust toward what he identifies as designers, even though what he envisions for game studies is to resemble an architecture school (see Aarseth, 2014).

15 I use Frayling's (1993) tripartite model because of its particular relevance to the case of videogame research.

16 Gameplay as means of research (Aarseth, 2003) is one of the most accepted methodologies in game studies.

17 Stenros and Kultima (2018) discuss in length the negligence of design-research in the field and its discourse as well as the benefits of its legitimization.

18 As Aarseth (2001c) points out, videogame spatiality "is also a way to explore the partly unknown, to test models and hypotheses, and thus to construct and acquire new knowledge in a way narrative never could." See also Günzel (2010).

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as "research-through-design" (RTD). Loosely identified as the development and documentation of experimental designs RTD can be considered as a middle-of-the-road research mode, that can sit in-between the existing modes of knowledge production: videogame production and game studies research. Its addition to this constellation is highly promising, since it essentially institutes a bridge between these two domains and their practices, which up until now do not show signs of cross-pollination.

More pointedly, RTD engages with the form of literacy pertaining specifically to the videogame medium which does not yet take part in the epistemic domain of game studies. It is also a form of research that can work in intimate synergy with existing game studies constituents, enabling the exploration of theoretical concepts parallel to their implementation through design. Furthermore, RTD can emphasize research that is less concerned with commercial instances of videogames and more with applications exploring the medium's potential in ways that commercial research practices are unlikely to pursue. Lastly, the combination of theoretical and design- research is highly valuable especially in matters of spatiality.[19]

19 As shown by scarce such examples (see Jakobsson, 2003) design investigations have a particular advantage over theoretical research in addressing existing research gaps and producing new knowledge.

Transfusion

The nature of spatial experiences pertaining specifically to Virtual Architecture cannot be prehended by traditional disciplines. Thus, design requires a new operational spatial framework to account for practical and conceptual facets of such experiences as well as for their aesthetic dimension.

From Space to Units of Experience

The investigation into the design and affective capacities of space specific to Virtual Architecture lies on our capacity to design such novel forms of space. Thus, the question of design media and especially the particular space they afford to design practice is crucial. Design software have been criticized to reside in conceptual models of the past.[20] The role of architectural geometry is particularly significant in this context since it carries philosophical ideas and values that architectural design necessarily inherits.[21] Providing simulations of space as the framework within which design takes place, design media essentially suggest specific concepts of space and rhetorics of its use. However, more than current theories and mathematical models of space, the space afforded to design by contemporary design media follows its Newtonian-Kantian conception implemented through the Cartesian model of Euclidean geometry.

20 Mitchel (2016) discussed architectural software that are modelled after "academic classicists" and thus carry ideologies and values of the past. See also Mitchell (2001).

21 For Woods (1996) the implications of the Cartesian design framework reach beyond practical ones to also affect the conceptual view of architectural space. See also Spiridonis' (2019) analysis of values embedded in architectural geometry.

Instead of space, I use the notion of spatiotemporality. Adopted from relativity physics, spatiotemporality rejects space and time as a priori categories and fuses them into a complex. In the model of Krauss'

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"expanded field"[22] which defies partial and historical understandings, similarly in this case, spatiotemporality institutes a "complex" at the intersections of disciplinary aesthetics and knowledges pertaining to space and time. As in relativity physics, instituting new conditions of 'space,' enables new forms and new understandings of subjectivity and eventually collectivity. [23]

The framework intended for the design and study of these environments relies on models of non-Euclidean geometry. This 'strand' of geometry remains almost unknown to architectural circles, Spiridonis highlights (2019), and thus "cannot have any impact on architectural thinking." However, we can draw from Relativity theory the model of Riemannian manifolds used to describe spacetime,[24] which can benefit design in a number of ways. On the one hand, manifolds provide an instrument to conceptualize and design spaces divergent from the current presuppositions of space as uniform and flat. Riemannian geometry therefore, enables for design the capacity to treat space as a variability, opening up a larger set of curved environments. On the other hand, concerned with both metric and non-metric qualities of space, it also provides a model to qualify spatial constitutions and enable their individual characterization as well as comparative analysis.

Through Riemannian geometry we can articulate units of experienceable environments to investigate the 'elements' of Virtual Architecture. As elements, these units are constituted by the interrelations of primary entities of spatiotemporal experience. DeLanda describes such a unit as an intensive assemblage:

> A good example is the assemblage which a walking animal forms with a piece of solid ground (which supplies a surface to walk) and with a gravitational field (which endows it with a given weight). Although the capacity to form an assemblage depends in part on the emergent properties of the interacting individuals (animal, ground, field) it is nevertheless not reducible to them. We may have exhaustive knowledge about an individual's properties and yet, not having observed it in interaction with other individuals, know nothing about its capacities. (DeLanda, 2013, p. 66)

The environment as assemblage is formed by the three heterogeneous entities coming together (animal, ground and gravity). The reciprocal relationships between these entities, as with various human activities (e.g., walking, scuba-diving, sailing, hand-gliding and spacewalking) give rise to altogether different assemblage qualities. For DeLanda different configurations yield different capacities, affordances and affective qualities. Furthermore, the range of variability of the configurations between the entities comprising the assemblage denotes a larger set or family of

22 Krauss (1979) suggested the notion of the "expanded field" to escape historical and positive disciplinary definitions.

23 See Wertheim's (2010) analysis of the cultural implications of scientific revolutions pertaining to space.

24 Manifolds, that belong to differential geometry, were suggested by Riemann a way to articulate spaces that bypasses the parallel postulate problem of Euclidean geometry. See Riemann (1854); Keyser (1906); DeLanda (2013) pp. 1-48.

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instances of qualitatively different environments. That, a multiplicity or manifold, is a larger space that contains unique instances of spaces as environmental assemblages.

The concept of multiplicity, as a larger space that contains spaces, can help clarify the term 'virtual' in Virtual Architecture. In this context, 'virtual' is more closely associated to Deleuze's concept of virtuality[25] than to virtual-reality technology. For Deleuze, the virtual is not the less real, but rather the possible that has not yet been actualized. DeLanda (2013, p. 65) sums up the virtual as unactualized tendencies and unactualized capacities to affect and be affected. In the same way, Virtual Architecture is concerned with exploring and activating unactualized tendencies in the configurations of the environmental assemblage and investigating their affective qualities.

25 Deleuze's notion of virtuality stems from the philosophy of Bergson. See Deleuze and Parnet (2007).

Such environmental assemblages can be investigated computationally using game-development engines and also experienced through VR. Videogame engines provide a platform to design and explore virtual interactive environments, where the relationships between the elements of the environmental assemblage mentioned before, can be calibrated through design. While game engines are locked in a Euclidean-Cartesian paradigm of space, unconventional implementations or 'hacks'[26] can still be used to implement spatial curvature thus altering the properties of the "ground" entity. Aspects of phenomenological intentionality (related to what DeLanda mentions as "walking animal") can also be customized computationally. Furthermore, physics-systems implemented in game engines allow for gravitational laws to be altered through design, leading to the investigation of alternative laws of physics.[27] Eventually, while videogame engines provide a suitable framework for the design investigation of virtual environmental assemblages, VR serves to render such environments experienceable in real-time, providing furthermore an ideal means to stage experiments in order to study their affective qualities.

26 It is unclear at the moment if the operational application of non-Euclidean geometry can be implemented also as a lower-lever feature in these software (for example through custom ray-tracers or shaders) besides workarounds that involving higher-level physics and geometry programming.

27 See Meillasoux's (2015) discussion of the philosophical implications of such investigations, which he terms 'extro-science fiction.'

Experiment Space

Besides rendering virtual environments experienceable, VR technology also serves as an ideal framework for their experimental study. For the past two decades VR has been employed in experiments in the fields of cognitive sciences and experimental psychology, and particularly for studies pertaining to spatial capacities (see Diersch and Wolbers, 2019; Bülthoff et al., 2008). In parallel, multiple studies have produced evidence to suggest that videogame-play can improve cognitive skills and capacities, and especially ones related to spatiality (see Subrahmanyam and Greenfield, 1994; Bavelier and Green, 2016; Uttal et al., 2013).

With videogames as means to advance spatial skills and VR as an ideal tool to study them, the fusion of VR and videogames appears particular-

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ly promising to investigate the potentials of spatiotemporal experience and the advancement of spatial skills (see Dünser et al., 2006). However, and even though VR-related artistic as well as game development practices are often concerned with developing such sensibilities, there is a lack of systematic studies on the subject.[28] While existing literature provides adequate tools and methods to study the practice and qualification of spatial skills in virtual environments, research into more experimental spatial configurations is rare,[29] since most studies in the domain of experience-research aim existing applied skills.

Nevertheless, the capacity for experimental investigations within the context of architecture is particularly significant. First and foremost, architecture's interest in aesthetic qualities of spatial experience provides an antipodal mode of investigation in comparison to existing ones. Furthermore, design knowledges and practices allow for the study of experience of virtual environments in close feedback loops with their design. Especially in the case of parallel investigation of media-specific environmental scenarios in correlation with the exploration of the limits of spatial experience, the advantageous position of architecture over other disciplinary domains is especially pronounced.

Conclusion

This research-creation corpus for Virtual Architecture stands for fostering of a knowledge and a form of knowing that is at the same time theoretical, conceptual, designerly as well as practiced, experiential and corporeal. It is an exploration of what a reconfiguration of given disciplines and their knowledges can do, both for the disciplines themselves and for us as its practitioners and affective audiences. In this way, Virtual Architecture stands as an alternative to conventional computational literacy and practice in architecture.

The research programme of Virtual architecture evokes processes of questioning and unlearning the historical and disciplinary traditions, the modes and origins of our sensing and understanding, in both the domains of design and experience. Its purpose is to unhinge notions of space and time from disciplinary biases, and mend the fragmentary understandings of the aesthetic. This disciplinary abstraction is a gesture of generosity[30] toward the potential of our sensory and sense-making capacities, and also of architecture as art and artistic expression unbounded by disciplinary and historical traditions. Through the exploration of media-specific spatiality Virtual Architecture aims to uncover promising new spectra of expression and creativity: new ways of knowing in latent capacities of intelligence and sensibility waiting to be discovered.

28 To some extent, the lack of more speculative studies can be credited to the interdisciplinary requirements of such investigations to combine both scientific and artistic capacities.

29 For such examples see Warren et al. (2017); Vasylevska et al. (2015); Oman (2007); Liu et al. (2016).

30 See Bühlman's (2017) discussion of abstraction as generosity.

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