Virtual Reality, Videogames, Architecture and Education

From utopian drawings to inconstructible navigable environments

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The paper suggests virtual reality (VR) as an architectural medium on the continuum of visionary architectural drawings of the past centuries. It argues that architecture and contemporary videogames engage with and share very similar concerns and aesthetic sensibilities. The potential of VR to develop designs and spatial configurations impossible to construct in physical reality but perfectly perceivable by our sensory apparatus, uncovers a latent domain of spatial aesthetics that architects can experiment with, develop and harness. The latter half of the paper discusses an experimental master studio module developed at the Institute of Architecture and Media of TU Graz, in which architecture students were called to develop interactive spatiotemporal environments in the VR videogame medium.

Keywords: *virtual reality, game design, education, spatial intelligence, videogames, game studies*

FROM ARCHITECTURAL PERSPECTIVE TO VIRTUAL REALITY

Drawing architecture

Virtual Reality (VR) devices have already entered multiple architecture offices and have become integrated in architectural practices, whether for design evaluation, visualization, or for client explication. VR and architecture however, have a longer past, as the two terms flirt throughout their history. From Brunelleschi's first mathematically-generated perspective experiment in front of the Baptistry (Edgerton, 2006), to Andrea Pozzo's trompe l'oeil frescoes on the ceiling of the St. Ignazio church in Rome, since its invention, architecture has employed perspective to transcend the limits of physical space. Besides, the invention of perspective that made the creation of visual spatial illusions possible, was first formalized by Brunelleschi's contemporary, architect and polymath Leon Battista Alberti. Alberti initially published "Della pittura" (1435) in Italian, followed by "De pictura" (1439-41) in Latin, as a more technical text. A lot has been written about the implications of the invention (or discovery) of perspective (Panofsky, 1992) in both the arts and sciences, that arguably gave rise to modernity (Jay, 1999) and scientific illustration (Edgerton, 1985). In addition, philosopher Paul Feyerabend, argued that Alberti's formalization of perspective, which became, in his time, a required knowledge for architects, was the single event that elevated architecture from an artisanal craft to a scientific profession (1999). Along the scientific revolution however, architecture also witnessed a simi-

lar revolution in the communication of designs, beyond textual descriptions this time, to scaled, and now printable diagrams. A straight edge and compass, along with the teachings of euclidean geometry, as "weapons of mass construction", could accurately reproduce any drawing at any scale (Carpo, 2017). Consequently, the ability to put ideas on paper, and being able to communicate them, produced a disjunction between architecture as built and architecture as the concept; the drawing. According to Carpo, for Alberti and the Italian humanists, the drawing was the original act of design, while the derived building was a mere copy of that intellectual property (2013). In the centuries to come, Piranesi produced his "carceri" and other imaginary landscape gravures, now studied for their architectural qualities. Similarly, visionary designs put forth by architects such as Boullée and Ledoux became more famous than buildings (Carpo, 2013). In the last century, conceptual architectures from Cedric Price to Yona Friedman, Archigram, Lebbeus Woods, Zaha Hadid, Bernard Tschumi and Rem Koolhaas, to name a few, explored the potential of what the drawing dimension of architecture could suggest. Perhaps Boullée was the one to phrase best the opposition to Vitruvius' triad of "firmitas, utilitas, venustas" that had already become the phantasm of western architecture: "What is architecture? Shall I join Vitruvius in defining it as the art of building? Indeed, no, for there is a flagrant error in this definition. Vitruvius mistakes the effect for the cause. [...] In order to execute, it is first necessary to conceive. It is this product of the mind, this process of creation that constitutes architecture and which can only consequently be defined as the art of designing and bringing to perfection any building whatsoever. Thus the art of construction is merely an auxiliary art which, in our opinion, could appropriately be called the scientific side of architecture"(Boullée, 1976).

Techno-virtuality

The 2nd half of the 20th century and the new wave of technological advancements, brought about new visions of technologically-mediated immersive spatiality. In 1955, Morton Heilig speculated on a futuristic form of cinema including stereoscopic vision, spatial audio, smell and haptics, as the unification locus of the arts (1992), which resulted in the "Sensorama" prototype. Ivan Sutherland, who developed the first Head Mounted Display (HMD) (1968) and initially speculated about an "ultimate display" that can materialize "Alice's wonderland" (1965) was none other than the inventor of the first CAD program, Sketchpad (1963) 5 years earlier, that suggests their continuum. In the decades to follow, and since digital HMD VR showed signs of it becoming technically feasible (Kelly, 1989) architects were among the first to adopt this technology and speculate in the extents of its use in their field. Following the cyberpunk culture introduced by Gibson (Gibson, 2016) VR pioneer Jaron Lanier argued for VR as a platform for a post-literacy in the form of post-symbolic communication through design (Lanier, 2011). Markos Novak wrote "Liquid Architectures in Cyberspace"(1992) already in 1992, while many academics, such as Bertol (1996), Anders (1998) and Schmidt (1995) explored further various applications and potentials of VR technology in its early years. In 2001 Kas Oosterhuis initiated the "Game Set and Match" (GSM) conference series at TU Delft, with a strong focus on the relationships between architecture and videogames. Its second iteration (Feireiss and Oosterhuis, 2006) in particular, devoted one third of its contributions to videogame related approaches, and starting with an introduction by Oosterhuis on the proximity of architectural and videogame design practices.

However, these initial experimental approaches have largely disappeared from the field of architecture, with VR today used mainly as a simulation and evaluation platform, and overall as a representational medium for designs intended to be built.

VIDEOGAMES AND SPATIAL DESIGN

Meanwhile, and gradually since the late 1970s, videogame grew to become the most profitable entertainment medium, doubling in the last decade the

earnings of the music industry and the film box office combined (Entertainment Software Association, 2015)(MPAA, 2015). In the year 2000, Game Studies, an academic field devoted to the theoretical investigation of videogames, was formalized, with many authors defending its autonomy (Aarseth, 2001a) (Frasca, 2003). In the end of the 1990s, the evolution of computer graphics and the availability of game consoles and personal computers produced a gradual shift towards the primacy of space in the design and practice of videogames. As Aarseth writes: "What distinguishes the cultural genre of computer games from others [...] is its preoccupation with space [...] games celebrate their spatial representation as their central motif and raison d'etre"(2001b). Similarly, Jenkins observes that space has become the underlying substrate on which games are organized, developed and played, drawing parallels between architectural and game design, proclaiming "game design as narrative architecture"(2004). Consequently, Günzel suggests the "spatial turn"(2010) as a paradigm shift in the development, practice and analysis of videogames. It is not uncommon today to find architectural readings such as Kevin Lynch, Michel de Certeau and Henri Lefebre, in game studies literature.

Game design: an accessible lively art

Videogames, having been around for about a century, have gradually emerged as an independent, rich and novel art form. As Aarseth writes: "Computer games are perhaps the richest cultural genre we have yet seen" (2001a). Jenkins has compared the videogame phenomenon to jazz music and its rise, as a "lively art"; public, accessible, non-institutionalized, however not trivial: "Games represent a new lively art, one as appropriate for the digital age as those earlier media were for the machine age. They open up new aesthetic experiences and transform the computer screen into a realm of experimentation and innovation that is broadly accessible. And games have been embraced by a public that has otherwise been unimpressed by much of what passes for digital art" (Jenkins, 2005).

Stemming from popular culture, videogames have become ubiquitous, not only in their consumption but also in their production. Game design software packages, are today even more accessible than standard CAD or BIM packages, which impose prohibiting costs for young, or up and coming architects. In contrast, game engines, have suggested a more friendly and fair business model, accessible to "indie developers". Unity and Unreal, two of the most popular game engines at the moment, are currently offering free unlimited-functionality licenses, only asking for royalties if their users' revenue exceeds a certain (relatively high) level. This openness to a range of users from beginners, amateurs and professionals has boosted both their popularity and also development, with multiple updates per month. They also feature very lively user communities and online fora, along with myriads of available video tutorials made by users, for every level and subject matter. Additionally, the fact that game engines employ GPU accelerated real-time graphics, has also made them quite attractive for architectural visualizations, which using traditional CPU-based rendering engines, presuppose multiple hours of rendering time. Furthermore, the fact that game engines offer both visual and scripting environments, along with capabilities for cross-platform deployment (also for mobile devices) leads to a very high degree of malleability, a fact that has made them a very attractive development platform for non-expert programmers, also, for producing applications that diverge from the videogame genre.

Lastly, since the release of the Steam online digital distribution platform in 2003 (Valve, 2003), videogame marketing has altered radically. Not only have such products become accessible through common broadband internet connections, but game developers also no longer require partnerships with distribution and publishing companies anymore, but instead can simply apply for publishing their products online. More recently the launch of the more democratic and less regulated Itch.io (Corcoran, 2013)

distribution platform in 2013, has made possible the sharing of experimental, shorter and often non-commercial games, as well as the formation of relevant communities.

Towards inconstructible architectures

We have argued before for the emergent properties of virtual space that we suggested could hence be justified as a novel spatial platform for architectural experimentation (Miltiadis, 2016a). It is however worth mentioning two distinct classes of spaces or architectures that are inherent to the videogame medium. On the one hand, and on the continuum of the visionary architectural drawing medium mentioned before, working with the materiality of digital geometries and game engines with optional or customizable physics behaviors can allow for designs, also animating ones, that are practically and statically impossible to build in physical reality, however possible to experience in the virtual domain.

On the other hand, a second class of impossible spaces goes beyond materiality, statics and the abundance for scenography afforded by a digital medium, to spatial constitutions that transgress physical space itself. Take for example M.C. Escher's "Relativity" (lithograph print, 1953) seemingly inspired by the frames of reference of relativity theory. Unlike other works of Escher, this print does not rely on perspective tricks that only work on paper, but instead depicts a space that while constructible is impossible to navigate in reality. Commercial games as for example Portal (Valve, 2007) and Antichamber (Demruth, 2013) have already introduced spatial configurations, which borrow concepts from the domains of physics and mathematics. Besides space however functioning as the visual medium of games, space also functions as the domain of embodiment and interaction in these virtual worlds, where players engage by practice. As such, videogames offer through space a different way of approaching knowledge and learning, which is not analytical but practical, and according to Fraser, relying on cunning reasoning and inventiveness (2011).

Videogames and spatial skills

In 1983, developmental psychologist Howard Gardner put forth his "Theory of Multiple Intelligences" (2011) in which he supported that intelligence is not a single "g factor", but instead comprises of different cognitive capacities. Gardner positioned "spatial intelligence" among these 7 capacities that have also been supported by experimental findings to be further developable through training. Motion-feedback flight simulators are one such example, in which military and commercial pilots train not only on the interface of planes, but also on their handling, developing therefore virtual aircraft navigational skills, that are transferable in reality. Already in 1985, Gagnon performed experiments proving that spatial cognitive skills related to certain professions (such as engineering, architecture and mathematics) can be effectively improved by playing videogames (1985). Among the supporters of Gardner's theory is architect Leon van Schaik who argued for spatial intelligence as the sensibility of architecture par excellence and vessel for its future, urging architects to experiment with architecture across media, including VR (2008).

The field of game studies as well as the practice of game design undeniably intersect with architectural thinking and practices, as well as with the aesthetic domain they deal with. We do believe that architecture can uncover a vast aesthetic potential that resides in the extensions of currently latent spatial sensibilities that are however intrinsic and media specific to the videogame medium and the kinesthetic embodiment in VR applications. Consequently, the videogame platform can offer for architecture an escape route from the cartesian flat-earth underlying paradigm that all CAD software share as an unquestionable given, and experiment with the potential of architecture in non-euclidean spatial constitutions. Such a step would pave the way to navigable environments (Manovich, 2001), that we cannot come across in physical reality, but our sensory and cognitive apparatus allow us to perfectly perceive, reason and act upon. These post-physical-world navigable spaces undeniably come with a novel surplus

aesthetic potential for architecture to explore.

THE VIRTUAL SPACES MASTER STUDIO

Given the above themes, and in order to test our research hypotheses of the proximity of architectural and game design practices, as well as the potential of virtual architecture and its richness, we introduced a relevant master studio class in architecture studies. The "Virtual Spaces Master Studio" was founded in 2016 and taught on 2 iterations at the Institute of Architecture and Media, TU Graz.

The only published relevant precedent courses we could find were Engeli's course at the Chair for CAAD of ETH Zurich (2003), a similar initiative at the Comparative Media Studies department of MIT (Fernandez-Vara et al., 2008) and a studio founded by Sanchez at the School of Architecture of USC (2013). However we could not draw much from these precedents. Engeli's interesting explorations are technically outdated, the MIT examples stemmed from a non-architectural department, and the focus of the USC studio was very different from ours.

Curriculum and structure

Given the lack of a relevant paradigm in architecture studies, based on our own knowledge and intuition, we devised our own curriculum for training architecture students in designing and developing virtual interactive spatiotemporal environments in the VR videogame medium, in the period of an academic semester and in the form of a master studio. The "Virtual Spaces Master Studio" module consisted of the main studio course plus two obligatory elective courses, accounting overall for 16 ECTS points and took place in the summer semesters of 2016 and 2017. The course was available to master students regardless of semester, and had 13 and 18 participants in the first and second iterations respectively. In terms of software, the course made use of, and was structured around the Unity game engine which is available for free. Additional software was also used primarily for low-poly modeling, image, sound and video editing. In the first iteration that was sponsored with GearVR HMDs and mobile devices, we used a setup which included a Kinect V2 sensor (for body tracking) synchronized with the application through a cloud server (similar in logic to the networking scheme used in "project Anywhere" (Miltiadis, 2015a) (Miltiadis, 2015b)). For the second iteration we used the HTC Vive platform that already includes wireless tracking, along with a stationary PC with a capable GPU. Between the two iterations of the studio, the curriculum was adjusted and improved, as will be discussed below.

Besides the relatively large amount of technical knowledge that had to be developed in order to effectively produce videogames, the course also required theoretical introductions to multiple fields and subjects. Therefore, the course was structured so as to distribute the development of technical, analytical and aesthetic skills, along with basic videogame literacy. The course was split in reading and discussion sessions, lectures covering various technical subjects, tutorial sessions on the Unity game engine. Overall, the subjects we had to engage with were C# scripting, low-poly modeling, texturing, video editing, sound design and game development, as well as concept design, creative writing, storyboarding, geometry, mathematics, and also game design and game analysis terminology and methodology.

Additionally, we covered 15 readings of papers, essays and articles from fields like game studies, media studies, narratology, critical and architecture theory. These were performed using the Hypothesis browser plugin (Hypothesis, 2016), that allowed us to create a virtual reading group, in which we could all collectively highlight, annotate and exchange remotely, while using the same platform and metadata we previously generated, for discussions in class.

Besides the classes, we also organized a series of auxiliary events targeted to nurture a sense of community, but also to acquaint students with digital and media art, the contemporary ecology and history of videogames, as well as different approaches towards both the analysis and development of videogames. These were guest lectures, educational trips, film

screenings, and gaming nights.

Physical limitation instead of studio theme

In the lack of relevant architectural research, we chose not to suggest a specific given thematic category, but rather encourage the students to appropriate the medium to their own ideas and furthermore employ it as an expressive platform for developing experimental spatial concepts. Instead, the only limitation we introduced, was the effective space that could be tracked by our VR system, resulting in the subtitle of "16m2 Labyrinths". "16m2" resulted from the 4x4m tracked area of our system, and "labyrinths" from the intrinsic "ergodic" (Aarseth, 1997) qualities of digital interactive space. Eventually, while this limitation initially problematized students, after a few lectures and programming sessions, they were able to come up with very inventive navigational mechanics, that were also organically incorporated in each projects' theme.

Course description

Throughout the teaching semester, we observed that architecture students, because of their practiced-based studies, indeed have an inherent fluency in developing, adapting and gradually shaping concepts for spatiotemporal interactive environments that proved our hypothesis of the proximity between videogame and architectural design. We also focused on producing one project per student, which, while demanding for the teaching team to support, was eventually very fruitful in exploring multiple individual approaches. Eventually, this proved that it is indeed possible for a single architecture student, given the necessary support, to learn the necessary tools and methods and develop an original project in the course of an academic semester. Furthermore, we acknowledged that architecture students are no strangers to learning new software and adapting their workflow in a short time period. In one semester most became very comfortable with developing content with the Unity3D game engine, low-poly modeling and texturing. However, we also noted that different students developed different technical skills and interests. Some preferred modeling and avoided scripting, or vice versa, while others developed extended project-based sensibilities like for example sound, interaction and visual design.

The subjects that required the most support from the teaching team were concept design and development and scripting. Since videogames are interactive, they need to produce different behaviors and they often have complex narratives or backstories, responsible for producing their world and the concept of the gameplay. Also while we were focusing on spatial matters, instead of adapting existing game concepts in our projects, we favored inventing our own. Though our sample group might not be large enough to generalize, we found that most students were capable in inventing navigational schemes and other spatial game mechanics, however fewer from the ones interested in creating more complex narratives interrelated with space were as capable as the first group, and therefore required frequent support in their conceptual development. This fact was not surprising since architecture studies do not often include subjects relevant to literature or creative writing. Also important to notice is the fact that architecture studies usually do not engage with the concept of time, progress, plot or interaction. Time-based design therefore should be treated as a subject to develop on its own.

In terms of scripting, the capacities of the students were rather mixed, depending on prior programming experience, interest in coding, as well as the scripting requirements across different projects. Roughly a third of the class was able to either code their whole project or contribute significantly. The rest would range from students who were able to only write a few lines, to others who would be able to continue on their own, given an initial, project-based program structure and occasional assistance when needed. Overall, the complexity of the Unity scripting framework and the requirement of a clean structure -also for the teacher to more effectively debug and assist the projects- are very difficult skills to master along all other requirements in a single semester.

Therefore, while we believe that scripting is a general skill that should be to some extend developed in architecture studies, earlier introductions would have been more beneficial to such scripting-heavy master courses.

In the first iteration, the auxiliary electives taught next to the studio course focused on sound design and film production, which, while useful, we eventually felt were too specialized and specific for our subject matter and more importantly our limited timeframe of one semester. In the second iteration we adapted the two electives towards developing technical skills, with the first focusing on low-poly modeling and the second on C# scripting and video editing, which proved eventually to be more productive and beneficial to the students and the development of their projects.

As mentioned before, the first iteration of the studio used mobile devices and real-time over-a-cloud, synchronized Kinect V2 sensors for tracking, which produced overall an overcomplicated setup for students to use. Even though we had 4 VR sets among 13 students, still, the difficulty - of developing on a computer, deploying on a mobile device to test and debug, and returning to the computer to improve and redeploy to test again - was very high. Additionally, using mobile phones, effectively introduced harsh limitations regarding the graphics quality and overall performance of the VR experience, as well as the application size and the quality of the assets used. Using an HTC Vive with a capable stationary computer in the second iteration, eliminated most of the practical problems we had witnessed before. Our initial fears that a single VR station for 18 students would create conflicts, eventually proved false, as the students were able to adequately timeshare the station, resulting in adequate time for everybody. However, an additional station would have been more comfortable.

Since Unity projects can be zipped and passed from one computer to another, keeping backups was possible and also easy, as well as the need of some students to transfer their projects and work on more capable stationary computers at home.

The course deliverables consisted of a working and playable VR application, a video trailer showing the project, a booklet documenting the project and its development and a poster.

The studio projects

In its 2 iterations, the studio produced 25 VR applications that dealt with a very wide range of topics, ranging from abstract experiences, interactive stories, spatial puzzle games and non-euclidean navigational games. While an exhaustive description of these projects would be impossible in this textual medium, we will provide brief descriptions to demonstrate the richness of the various approaches undertaken, as well as of the overall course output. To do so, we will split the projects in three main categories. Although most projects draw from more than one of these categories, the primarily ascribe to one. These main overarching topics are:

1. Navigability mechanics themed projects
2. Narrative projects
3. Abstract experiential project

Navigability mechanics themed projects. The first category of projects dealt with inventing mechanisms for navigation. The limitation of a 4x4m tracking space created for many a need to introduce different ways in order to maximize virtual space over the given physical space. While most of the produced games used some sort of teleportation or artificial locomotion, projects in this category were built around such mechanics. “Basic Needs” (David Seiwald, 2016) is a game where the player has to solve a simplified Rubik’s cube, by being on top of it. This shift of perspective, from extrinsic to intrinsic, transformed the solution of the cube to an interesting spatial challenge, also for experienced solvers. “Moving” (Lukas Meindl, 2017) used the players movements to remotely control a puppet in avoiding obstacles. Starting by mirroring the player’s movement, the game progressively becomes harder, as different transformations and asymmetries are introduced in the cor-

relation of the coordinate systems of the player and the puppet. "Beyond Space" (Björn Seidl, 2016) used an unintuitive teleportation scheme based on vision and occlusion, that challenged the navigation conventions of the player. "The Room Dilemma" (Katrin Wutte, 2016) used a rotational elevator in traversing a house, that produced configurations in which the player would walk on walls and ceilings. "Gyro" (Primoz Brglez, 2016) employed a teleportation scheme on a voxelized blob structure that would challenge the player's sense of orientation since no uniform down direction was preserved. Similarly, "Labyrinth" (Xin Guo, 2016) inspired by non-euclidean geometries, used linear and spherical-path elevators for traversing the space, that on the one hand maximized space creatively, and on the other, produced complex navigational paths, that suggested new forms of spatial orientation.

Narrative games. The second category includes games focused on narrative, either linguistic, visual or environmental (Jenkins, 2004). A few such examples are "Future Visions" (Philipp Schnitzhofer, 2016) which featured multiple interactive and animated environments inspired by the graphic novel "Citizens of no place" (Lai, 2012) and "The Game of the Goose" (Dinko Jelecevic, 2017) which guided the user through a choreographed sequence of spaces inspired by the life and works of Aldo Rossi. More linguistic approaches were "Ghost Talk" (Emina Lozzo, 2017) which speculated on the life and world of the pac-man ghosts after game over, and in "Escape from the Unknown" (Petrit Vejseli, 2017) inspired by the Turing test, the player is found in an android factory, questioning their identity. Yet, another approach was "Chronicles" (Valentin Moser, 2017) that featured an interactive storyboard of 3 parallel timelines of 4 episodes each. The player, before each episode would chose which timeline to follow, therefore creating a custom narrative path, that would only consume 1/3 of the content, resulting in a completely different experience at every gameplay. Besides the initial narrated introduction, all episodes relied on visual cues to abstractly communicate their diegetic dimension. Furthermore, the final scene of the game, was procedurally generated and populated by objects from the player's previous episode selection.

Abstract experiences. This category of projects comprises of more conceptual projects, which focus on aesthetic experience. While loosely depending on some minimal narrative structure, they remain mostly abstract. Examples were "Library of the Absurd" (Philipp Sattler, 2017) that produced a series of very different evocative spaces inspired by various books and artworks, that overall challenged the player's sense of agency in the game. "Awakening" (Lukas Gosch, 2018) situates the player in the cockpit of a spaceship out of control, with the task of avoiding a collision with a meteor. The unavoidability of crashing and the unexpected ending, eventually function as a meditation on the nature of simulations. "Architecture of I" (Kelly Man, 2016) dealt with a gradual buildup of sensory dimensions (time, sound, vision, space) leading to a suggestion of sublimity. Finally, "#O" (Xaver Burkart, 2018) used only grids, lights and sound, to form a minimal but captivating experience of a passage through the different phase states of matter (solid, liquid and gas).

Retrospective evaluation

Overall, we observed that the studio topic, provided a great motivation for the students to engage with the development of both technical and conceptual skills with great enthusiasm. Also, the students felt positively challenged to engage in investing and learning contemporary skills and consider videogames seriously as research-worthy objects. Additionally, teaching a game engine in a project-based manner, created more of a "playful learning" atmosphere. While not all students admitted to be gamers, or to have prior gaming experience, most were fascinated by the capacity to produce videogame projects, also potentially comparable in many aspects to commercial videogames.

Nevertheless the studios required constant and active participation from the students, as well as a very close tutoring and assistance by the teaching

team, that overall contributed to a very intense however very productive semester.

Eventually, 5 out of the 31 students of these classes expressed their interest to develop their master theses on the subject matter of the studio, while many continued to develop their VR applications for release and a few others were involved professionally with game design firms.

As architecture lies comfortably between theory, art, science and design practice, we support that this approach is particularly suited for further investigations in similar architecture design classes. Even for students who will not pursue relevant professional paths, both the theoretical and technical skills developed during the course, were retroactively seen by the students as very beneficial for their development. Additionally, architects as well as architecture students seem to be particularly able to apply their skills and talents to videogame development methodologies and workflows, both productively and creatively. Furthermore, the lack of precedents, allowed for approaches with a high degree of originality.

The detailed curricula along with documentation and video trailers of the produced projects of both iterations can be found online (Miltiadis, 2017) (Miltiadis, 2016b).

CONCLUSION

This paper intends to contribute findings from the above mentioned experimental design studio which developed its own curriculum and effectively led students to develop high quality VR applications. The produced projects, dealt with a wide spectrum of topics, hinting the promising potential of virtual space. While both videogames and VR are becoming more and more ubiquitous, their obsession with space, inevitably brings them progressively closer to the sensibility and practices of the architecture discipline. Therefore, the above course descriptions and findings might be beneficial for academics who want to pursue the foundation of similar courses or initiatives. We do believe that the digital realm has a lot to offer to architecture, and as it has been previously suggested (Miltiadis, 2016a) can function as a novel spatial platform for architectural experimentation, beyond the use of VR as a utilitarian representational medium. In conclusion, such explorations uncover a large domain of unexplored aesthetic potential, residing in post-physical-world navigable environments that, while impossible to physically construct, are perfectly perceivable and can engage us with extensions of our spatial sensory capacities and aesthetic sensibilities that are currently latent.

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