

Digital Immersion - case studies in virtual reality

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Abstract. Digital tools have transformed the ways we generate designs, pushing the boundaries in formal explorations, as well as the ways we represent them. In this vein, the impacts of the digital revolution affect both design practice and design education. We would like to investigate these impacts on our teaching of design studios, focusing on the virtual reality. Our premise is that the use of first-person immersion in a virtual environment is a means for experiencing space. We are interested in ways in which the abilities of virtual reality to simulate ranges of sensorial information could inform design processes. This paper will report in our research in our teaching that speculated about the values and application of these techniques. This paper aims to discuss our learning processes and experiences as well as to reflect on possibilities of digital means effective design pedagogy.

1 Introduction

“What is taking place is a radical extension of the body and a reframing of its sensorium,” he suggested, as computer technologies offer a “multi-layered reality” for redirecting our senses. Instead of “the heroic individual,” what will emerge is “a multiplication of sub-selves inside a networked individual.” – Antoine Picon [1]

As in every aspect of life, digital tools have revolutionized the design world. It has transformed the ways we generate designs, as well as represent them. In terms of generative design, their capabilities for investigations of complex shapes allows for explorations of non-Euclidean geometries, in contrast to the limited formal vocabularies of conventional tools. Not only do these tools offer means to generate those geometries, they also allowed for geometric modeling techniques that is very intuitive, such as in parametric designs. Digital tools have also opened up new possibilities and opportunities in realizing design ideas into real structures. Digital fabrication techniques have offered ways to fabricate those formal explorations at the scale of a building. Along this line, building information modeling has helped in constructing buildings in much more integrated and sophisticated ways. In this line of thought, this paper will report in our research in our teaching that speculated about the values and application of these techniques within architectural designs. How can we develop methodologies to use virtual reality to contribute in the design process, not only in terms of representations, but also in generating design? Through this study we document and explore ways in which techniques in virtual reality cover aspects of creating, documenting and delivering decisions about space and professional communications. This paper aims to

discuss our learning processes and experiences as well as to reflect on possibilities of digital means effective design pedagogy.

2 Background Thoughts

Digital tools pushed the boundaries of the geometry in generating designs. In the past, using manual tools, designers had to rely on descriptive geometries to arrive at satisfying forms. The tools and the techniques limited the possible explorations of geometric shapes within the realm of Euclidian geometry, limiting the geometry of design to basic shapes and their three-dimensional derivatives. The computational capacities of the digital world changed the situations. With powerful engines, contemporary computers were able to perform much more complex computations in shorter time. Software keeps evolving to facilitate, taking advantages of the advances in the hardware. This phenomenon led to the design explorations in complex geometry such as folding, for example, with examples in practice in the work of Diller Scofidio + Renfro used folding techniques in their design. Even folding in design has been discussed in relations to the philosophy of Leibniz [2]. Another foray into formal investigations opened up by digital tools was the emergence of blob architecture, or Binary Large Object [3]. If Euclidian geometry featured angled intersections of line and planes, blob offered continuous and sinuous geometry, which could resemble organic entities. Some architectural work, such as those by Greg Lynn and Future System, exemplified the use of blob. As Picon has pointed out, in terms of software, the advance in Wire-frame, solid modeling, NURBS (NonUniform Rational B-Splines) have facilitated designers to explore geometry of design in much more intuitive and complex [4]. These innovative geometries understandably led to the fascinations with forms. This indicated shifts from Euclidean geometries to topologies, as discussed by McGrath and Garden, among others [5]. Architecture, however, is not only a matter of form, but also, about space. How the digital revolution in design deal with spatial aspect of design is an interesting point. One way related to this issue pointed to the depictions of space generated by design. A type of computer-generated three-dimensional representations is virtual reality. As computing power increases and software broadens, the use of virtual reality environments and immersion simulations are becoming more accessible. With virtual reality, visualization is no longer dependent on conventional architectural projection drawings such as plans, elevations, sections and perspectives. Instead, it allows for immersion that offered potential advantages of virtual interaction, an experience that is not only isolated with the designer but also open to participant. Designers and participants could engage in the discovery, understanding, and experience of space.

The impacts of the digital revolution affect both design practice and design education. In this vein, we would like to investigate these impacts on our teaching of design studios. Salama has pointed to four aspects of architectural education [6]. The academic aspect dealt with compositional theories and formal design while craftsmanship instilled in students' proficiencies in design trades, including aptitude in digital tools. The latter related to the technological aspect, including building technology as well as technology for various aspects of design processes, including that of digital representations. Along this line, we believe that technical understanding could stimulate imaginations. We are interested in the relationship between design representations through digital media and design thinking, especially in the use of virtual reality in the design studios. We set up our research in the design studio by pairing virtual reality with conventional design processes.

3 Student Case Studies

3.1 Case Study 01: Jose Rodriguez

In our early case study, entitled “*Constructed Reality, A Study in Spatial Perception through Virtual Reality*”, Jose Rodriguez was interested in investigating the nature between drawing and space while harnessing the malleability of virtual space. At the beginning of his thesis he asked a simple question, with VR can we experience a drawing? His research indicated that perception and visualization remain the human system responsible for organization, identification and interpretation of sensory information. He argued that VR could bridge the modes of representation between the human eye and the digital lens to create immersive spatial experiences. His research started by taking a historical look at representation and creating a graphical timeline that tracked how representation has changed over time. He concluded that representation had evolved from static one- and two-dimensional representations to dynamic three-point perspectives and collaging. As time passed and the development of how we reproduce improved, complex ideas were better represented and communicated. The study revealed an emphasis of perspectival representation heavily influenced by Brunelleschi’s perspective method of tracing reality.



Fig. 1. Rodriguez, Timeline of representation.

Examples from the timeline were analyzed for how they were constructed, identifying parameters of perspective and categorized into the types of experiences and feelings they invoked. The findings of these exercises allowed the project to begin understanding the correlation between representations and the categories of experiences. Further analysis focused on perceptions of space and visualization of space. Findings from these perspective drawing studies served as an influence for understanding static vs dynamic representation. In this light, perspective was used as a way to model spatial perceptions. As the analysis of spatial perceptions advanced Jose, sought out other mediums that communicate feeling or ideas. He concluded that static perspective was created by drawings and photos while movies created moving perspectives. This led to looking at techniques in moving perspectives from cinema. The study then focused on the connection that architectural representation and film have in the way a scene is constructed in order to communicate a feeling or an idea. Film has always immersed us into representations to communicate an expression. Using cinematic principles, he questioned whether we can gain an understanding on how to construct a spatial experience in architectural representation. A questionnaire was developed based on comparing manual perspectives and digital perspectives. It was interested in capturing feedback about perception of space for both architecture and non-design participants. This led to the development of two modules to test ideas learning about the perception of space now in a virtual world.

The first module of exploration in the virtual environment was a study of Le Corbusier's Villa Savoye and how to further understand Le Corbusier's Five Points of Architecture. By using software to model and then porting into a gaming engine, an immersion environment was created to illustrate a dynamic understanding of what Corbusier wanted the user to experience. By using the gaming engine's capabilities, scripts were incorporated to make the environment even more informative with the advantage of being able to tweak the environment itself and allowed the user to filter information to further represent the five points. This case study helped to fully learn the capabilities and disadvantages of the workflow as well as an understanding where the project could head towards in the next stage. The conclusion gained from this exploration was that this was an immersion through input.

The second module in the study of perception in virtual space, used Francesco Borromini's gallery at Palazzo Spada as a precedent. Building on the first module this project looked to replicate an environment of immersion and experience. Again, virtual reality would be employed to study perception and user experience. This time, a user was asked to question the actual size of the space. The gallery columns, vaults, and floors were angled so that a space on a floor plan would normally read at 60 feet long, actually is only 28 feet long. The user's vision is challenged to comprehend the size of the space. It is not until you reach the interior that it becomes apparent the space has been modified. The project led to design strategies based on scale that transformed using physical alterations to manipulate a space.

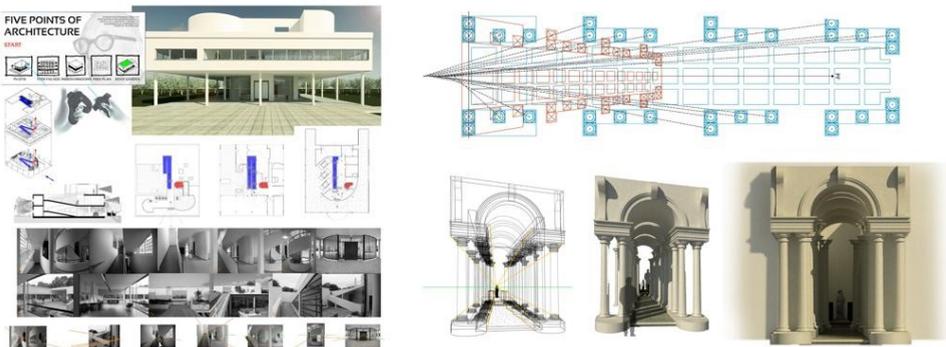


Fig. 2. Rodriguez, Module 01, Villa Savoye VR (left) Francesco Borromini's gallery at Palazzo Spada VR (right)

The final outcome for the thesis was a digital environment entitled "*Immersion Lab*", that encouraged spatial exploration for immersive and dynamic experience. Drawing on earlier modules the project was envisioned as an immersive space based on the synthesis of cinematic representation that allowed a user to experience different types of feelings. The lab was divided into portal exploring two parts of perception, happiness and fear. Villa Savoye, from module one provided the context. First happy, where it is placed in a bright and sunny forest setting complete with a light breeze and birds chirping as you travel down a path, and secondly fear, situates the building in a desolate, post-apocalyptic and damaged environment dark with the occasional rain drop and you hear the wind. A haunting soundtrack quietly plays as the user passes through the shadows. Just like mise-en-scene, the components of the environment could be altered independently so to provide different variations of experience in the desire to create new and unique experiences.

He concluded that the stock experiences presented in the portals helped perception but stayed in the realm of representation and not experience. With virtual reality, the immersion and interactions happened at true scale perhaps illustrating the connection to body and space.

The representation of happiness and fear were significant by themselves but because portals were separate environments there was now link between the two and could be more powerful if they were combined allowing greater interaction between one another.

3.2 Case Study 02: Jay Joyner

In our second case studio, entitled, “*Deciphering Sacred Space, Testing Virtual Reality Through Exploration of Sacred Spaces,*” student Jay Joyner was interested in light phenomenon and immersive experiences as a design tool. His question was whether virtual reality technologies could be used as more than a representational tool. Specifically, he was testing whether VR could immerse the body and allow a designer to test and experience parameters within a virtual space. The research developed in two parallel tracks, understanding light in architecture and developing the technical skills required for application in the virtual environment. The former started with an interest in the essays of Luis Kahn which outlined his design process that begins with the immeasurable and then built through the measurable. Once the architecture is built, the immeasurable starts living again. To further understand the impact of light on architecture the research lead to Marietta Millet and her book, “*Light Revealing Architecture,*” which explores principles of lighting in architecture and how specific lighting effects are realized architecturally. Through orthographic projections, diagrams and renderings Millet looks at contemporary and historical architecture through the lenses of experience, form, space, and meaning. This line of inquiry resulted in a series of cases studies where the student analyzed three case studies known for their use of light, Church of light by Tadao Ando, Kimbell Art Museum by Louis Khan and Chapel of Notre-Dame-Du-Haut by Le Corbusier. In some sense, the research was investigating an analog approach to understanding digital media.

One of the challenges of VR is the required knowledge and technology to stitch all the pieces together. Beginning research focused on developing the skills with the digital tools and techniques of modeling digital light. Small artefact models were used to create and understand different lighting methods and their effects. For the project, the students chose to use Unity software and Oculus Rift VR eyewear. Early digital experiments allowed interaction with light at a human scale with the Oculus Rift. Precedent studies were modeled and evaluated in VR. The analog drawings from the case studies were created digitally with a focus on transforming light that was changed through a series of apertures, filters, and openings. In order to evaluate the digital environments, attention was given to changing the context of each precedent. The outcome was to produce a taxonomy of parameters for light phenomena.

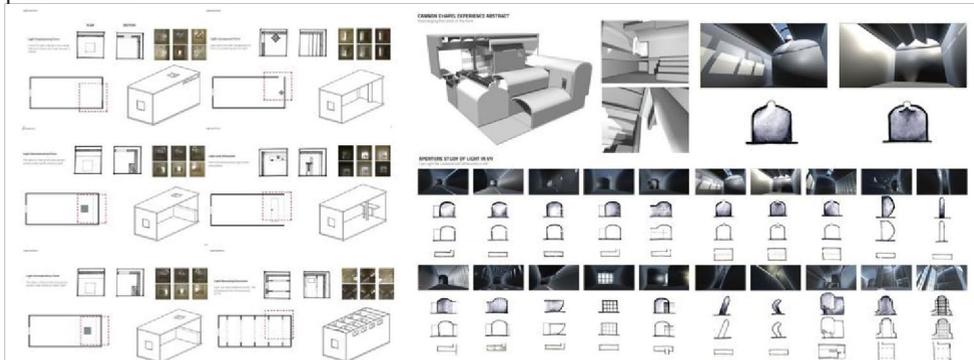


Fig. 3. Joyner, Analog light and digital light studies (left), Cannon Chapel artifact VR (right).

In order for this the thesis to be used as a tool, the “measurable” need to be defined. Again, a combination of analog and digital experience was used. The student set out to visit Cannon Chapel by Michael Graves on the Emory campus. This sacred space is known for its use of light and space. A combination of digital studies and narrative experiences were used to analyze the space resulting experience matrix that documented light, depth, and form through a narrative passage as well as a series of drawings diagrams and sketches.

After experiencing Cannon Chapel at Emory University, he created an artifact of his analysis. The resulting VR model was interested in linking what we had experienced with the virtual world and the digital realm. The arrangement of the artifact was configured based on the analysis of light and space. Materials were not included in the were study so the investigation would focus on light, space, and form.

Empowered by the success of capturing the “measurable” in the prototype digital artifact, Jay proposed creating a VR game to test his hypothesis of digital immersion. Utilizing the taxonomy developed in the research of sacred spaces the game focused on five aspects of understanding architectural spaces, form, space, order, tectonics, and light. Linking to his earlier research, Jay envisioned developing the game to explore the relationship between light, order and materiality. The strategy allowed users to choose design parameters while making design decisions within the different categories to create new sacred spaces and experiences.

3.3 Case Study 03: Holden Holley

In our third case study, entitled “*Beyond Flat Space: Representing Architecture in Virtual Reality*”, Holden Holly explores the use of virtual reality as a communication device. Of particular interest was the question of how could VR be used to communicate with clients to influence design intentions and client understanding. Holden speculated if he could harness the information present in a BIM model to efficiently create virtual reality.

Holden argued that drawings once done on a drafting board are now being constructed in BIM programs like Revit and believed that constructing a BIM model represented a majority of the work of moving to VR and would easily dispel clients concerns with cost.

Early research focused on the available of hardware and software. Of particular interest in the modeling process was the integration of virtual software within these programs. He researched the interoperability of design and production programs to work together. For instance, Revit can use almost any BIM file type and convert to almost any file type as well. This allows for seamless transitions through different design software and allows for the use of virtual design methods without changing too much of our current design process. It can be as simple as a plugin for our current software or as complex as exporting to another software. This led to the use of Enscape with Revit.

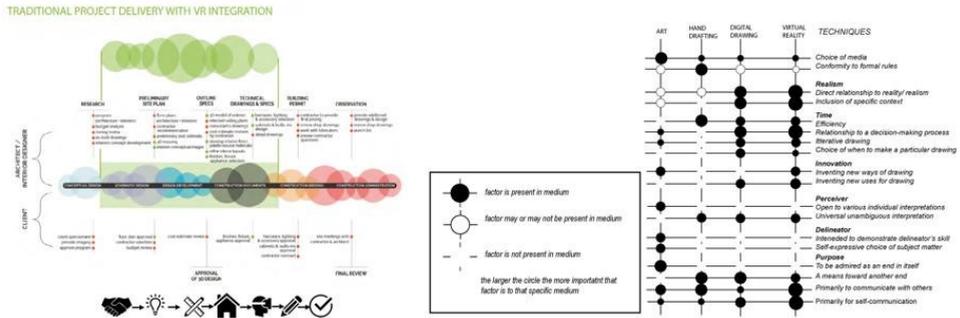


Fig. 4. Holley, Tradition design workflow integrating virtual reality (left), Representational style analysis including virtual reality (right).

Parallel to software and hardware analysis Holden speculated how this technology could be integrated into a traditional project delivery method. He concluded that virtual reality could be used anywhere from late stage schematic design to construction documentation, due to its integration within our current processes and software. For his research Holden developed a matrix of virtual reality representational techniques and their definitions. Current reality as defined as “what is”, “what already exists”, or “the norm”. Augmented Reality as a digital overlay on real scenes. A mix of computer-generated images and real-world photos. A new category called augmented virtuality utilizes virtual imagery with a layer of realism. It is more in depth and more virtual than augmented reality. Virtual reality, the area of his research, is the category of “what could be”, completely generated by digital means. This study led to the developed a comparison of representational techniques in with virtual reality which illustrated different types of design media and the strengths and weaknesses of each based on measurable attributes. He analyzed that virtual reality is very good at simulating realism and can be used for both self-communication and communication with others. He concluded that virtual reality not only helps us as designers see realistically how these spaces come together, but it also is equally as good at showing clients the same information about these spaces. He cited five reasons to use VR in architecture, the ability to make changes on the go, an added billable value to the project, increased attention at presentations, the media allows for long-distance presentations and the ability to persuade a client based on visuals. His final project tested these ideas with a collaborative effort to create a VR presentation of a fellow student’s urban intervention project which called for series of spatial experiences.

4 Discussions and Reflections

In a way, virtual world could serve as a new prosthetic, an extension of the human body to experience spaces. Technological advances not only expanded possibilities for visual experiences of space, but also allowed integrations of the use of other senses in experiencing space, hence, simulating both visual and haptic experiences of space. We are interested in these abilities to simulate ranges of sensorial information could inform the design thinking. They gave new ways to simulate space and evaluate beyond the formal aspects of spaces, its shapes and dimensions, into the ability to feel spaces. Indeed, these simulations allowed designers to assess factors including the effects of colors, textures, materiality, and lighting conditions, both natural and artificial. Thus, they allowed for the increasing capacities to assess and evaluate the performance of space that underlined efficacy of design explorations. In this line of thought, Picon pointed to emerging notions of affect and elegance [7]. The latter referred to the aesthetic aspect of formal explorations; a way to assess and appreciate the formal results of design explorations that accentuated the richness and complexity of

geometric shapes, yet maintained the coherence. Picon cited the description of elegance by Ali Rahim and Hina Jamelle as a quality obtained :

“through the creation of a family of formal features that are distinctive, yet remain interrelated as the transform form one to another” [8]. The former, affect, covered the performative aspects of design, the way design elements modulated space and created sensory experiences. It is concerned with ways in which design moves informed and affected spatial conditions and the behavior of spaces, informing spatial experiences beyond given programs. A factor that could determine spatial experiences would be the design of surfaces. Along this line, Moussavi has developed arguments that ornaments and other design of surfaces were more than creating visual interests, but creating sensations and affects in space [9]. The notion of affect, with regards to both the foray into design of surfaces and to the impacts on spatial experiences, underlined what Picon called as the spatial turn and spatialised-intelligence, in which knowledge embedded in space [10]. Hence, our perceptions and experience of space carried with them some forms of knowledge, most importantly the knowledge on spatial organizations and manipulation. Simulations of spatial experiences through digital simulations offer the possibilities to uncover and explore this knowledge. Hence, digital tools foregrounded the primary role of space, as they were a tool not only to generate design, but also to feel space. These investigations attempted to understand the relationship between the human body and one’s spatial context.

In this research in design teaching, we are interested in the notion of spatialized intelligence, that space itself carried with it a range of knowledge that designers and users could unearth. In this line of thought, digital simulation produced virtual spaces that designers and users could experience, even though they were still in the realm of ideas. The question for us was to find a model to understand this thought process, in which we turned to the notion of cybernetics or feedback loops. McGrath and Gardner identified several features in cybernetic [11]. The cybernetic process looked at the whole context, hence, architecture in relationship to all factors that informed it, including contexts and users, instead of architecture as a free-standing object. Because of this, the inquiries turned to explore relationships and mapping those. The findings of this would be the patterns of these relationships and their qualitative aspects. The thought process itself worked from continues feedback loop instead of in a linear fashion. Our work with students demonstrated that constructing virtual models allowed them to immediately assess spatial conditions as a result of design iterations. These virtual models allowed them to bring together changes and alterations of various factors, including changes in plans, sections, elevations, openings, and surface conditions. They also allowed for modification with regards to the site and site conditions. Hence, their virtual models provided a means to integrate relationship between various space-defining elements, between space and the environment, and between space and users inside and outside the space. Further, the models provided the results of these integration immediately. In this sense, the models served to map relationship that emerged in the design process. Each design iteration proceeded with feedback generated by these virtual models.

This finding related to the nature of design thinking itself. With regards to the generative process of work of arts, Nelson Goodman has distinguished the types of ways in which the work emerged into autographic and allographic works [12]. The former was a way in which the work of art was produced directly by the hands of the artists, such as paintings and sculptures. On the other hand, allographic was a way in which artists worked indirectly in creating work of art. It required media through which the artist worked to realize the work. Architecture fell within this category, since architects produced drawings instead of

buildings. Obviously, in our inquiry, the production of architectural representations, both drawings and models, happened digitally. As we documented in our research, students had to work with multiple software and hardware, each of which required a certain level of competency. The implications were the need on the aptitude in working with software, as well as in connecting between software.

In reflections, our experience with these projects demonstrated that virtual models and digital immersion are less of a design tool. Instead, they remain at the level of tools for architectural representations. The projects that we worked with tended to focus more on technical issues, mainly learning in mastering software and hardware. As a consequence, the process of those projects was less on exploring spatial and formal aspects of design, but more on constructing representations of design. Engaging this mode of architectural production, in terms of design pedagogy, seems to result in developing the skills and ability and less in understanding of architectural design. Hence, it is more on the vocational side and less on the academic dimensions. A distance emerged between the digital fluency and the spatial knowledge. On the other hand, it led to a knowledge in connecting different digital tools. In a way, the problems during the process seemed to shift away from simply dealing with ordering space and form to figuring out ways in which software and hardware work and, more importantly, strategies to connect those digital tools.

Their value, however, lays in their capacities to widen the possibilities of understanding the impacts of design decisions. Especially, it lays in their efficacy in providing that information. This strategy allowed an engagement with design results, as it allowed viewers to be inside a space, and highlighted relationship between various design variables. This mode allowed to integrate changes and map the result. Further, it allows for developing ways to measure changes. Hence, it maps changes and results from that changes. The case with case 1, Joyner developed tools to change surface properties, of which the models allowed us to assess the impacts; while with case 2, Rodriguez developed tools to control variables in perspective. In this line of thought, this mode allowed for controlling changes in a measurable manner. In a way, this mode provided a means to quantify atmosphere. This would be the potential in which digital immersion could serve as a means in activating the feedback loop processes.

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