Abstract. This paper proposes virtual spaces designed in Game Engines promote a form of inhabitant hyperactivity. Allowing quick navigation between distant spaces the Game Engine fosters an appreciation of movement over pause, which may be to the detriment of architectural visualisation. This paper presents a series of three case studies that explore the notion of Real-Time Streaming Data within RTVE to enrich and enhance Virtual Environments. This paper proposes the notion of ‘Digital Ephemera’ can help produce a more immersive virtual environment. Based on the examination of these case studies, the paper concludes on a motion that breaking down the inherent ‘stillness’ of traditional RTVE’s can be avoided by developing an environment that taps into data streaming and monitoring services to enhance the inhabitant experience.

1. Introduction

The core concern here is that the CAAD community has placed a particular tool at its centre and that is the ‘Computer’. While not attempting to deny how beneficial it has been to the wider field of Architecture, there seems to be in architecture a larger impression looming that this ‘media’ as in the products produced through computing, are removed from the real business of brick and mortar. The CAAD research community has, as have many other fields taken it upon themselves to explore the ways that the computer can be used to aid and influence Architectural Design. I think that this slightly removed concept, of RTVE in relation operates as some kind of aberration, where visualisation, or representation, uniquely linked, yet also exclusively abstracted and excluded from the key subject - that is ‘Architecture’. Then, is RTVE (and possibly all representation) not a glitch to the discipline? If we to consider it was a glitch, we could then learn something from these glitches as we know that by being made aware of an abstraction, we indeed learn or at least are allowed to focus in on a truly important characteristic of architecture.
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1.1. POSITIONS ON PHOTOGRAPHY

The photograph is an interesting construction to study in the context of CAAD. Photography is an exceptionally powerful tool when undertaking a study of architecture. I doubt there will be a single person in the field who has visited more well known and significant buildings than they have explored and come to know through the viewing of photography. So inextricably connected to photography is Architecture that we see a very early use of photography used explicitly to record and map out buildings of cultural significance by the French government in the 19th.C. Such an exercise then allows us to consider the photograph have been offered considerable agency to replace, or at best stand proxy for buildings built from a physical material. Here then, we really find the interesting linkage to CAAD in that the photograph is wholly constructed through various apparatus and tools, and all in the aid of as Patrick Maynard states ‘To effect marks upon a surface’ (Maynard 1997, p. 37). These marks are also, made at distance to the building, and also consumed remotely. Such a fundamental activity of modern life, the viewing of remote spaces through photography offers, or perhaps persuades the viewer the feeling of an authentic experience. Indeed, the viewing of the photograph is made possible by suspending the image before the eyes and allowing the reflected light to enter our eyes. We look at the image of a building and consider we have seen it. It is very very difficult to distinguish in our mind’s eye, what we have seen, and what we have seen through seeing photographs. Both activities are seeing, and both lead us to an understanding of material, form, space or otherwise. Here we find a startling reality in the field of architecture where the medium of photography is almost permitted to be consumed as if it was an architectural experience.

1.2. ON GAME DESIGN

Numerous researchers have espoused the charismatic inhabitation of space within games (Moleta 2016; Moloney 2005). MMORPG, FPS, Open World, Building Games and so on have now captured the attention of at least two generations since the late 70’s and increasingly so in present society (Niche 2009). It is not hard to find a person who has not dedicated a whole afternoon, weekend or even month to working out the intricacies of a particular tile’s environment. There is also the distinction that ‘games’ are designed to be engaging, or challenging and that is the driver key incubating their inhabitation. Conversely, there is a range of environments that simply permit inhabitation and allow some minor alterations. An exemplar of this type of ‘game’ is Mine-Craft. Games of this genre are termed ‘Sand Box’, which hints at a space to author and create forms or spaces. Mimicking childhood activity of exploring form making in a physical media, the motiva-
tion is the simple pleasure attained through ‘building’, destroying and re-building. There is also a degree of enjoyment of observing the works of others, this is also carried across in Mine-Craft, where a large portion of inhabitants occupies the digital environment by moving about the various spaces admiring the works of others. A virtual tourism of a sort, and not altogether different from exploring a remote city via google street view from abroad. If we were permitted, we might draw a connection to the construction of designed spaces made by others in the virtual in alignment to that of the built world. Both, the virtualization of the real world (representation of existing buildings), and the virtual world (creation of non-existing buildings) are able to be experienced by the same mechanisms (i.e. Sight, Computer Screen), drawing the distinction inhabitants behaviour between the real and the virtual into close proximity.

2. Case Study One: Photorealistic VR Space

The first body of work falls into the field of architectural visualisation in the exact map of the terminology. It is visual and highly so. The materials are all carefully prepared and photo mapped onto the digital model. The environment looks as real as any given photograph. The procedure undertaken first generates a terrain map using high-resolution GIS data to reveal a high-poly mesh. This is then downsamples to produce a more stable and navigable site model. Following this, (figure 1) a trip to the site is undertaken and photogrammetry is used to collate key geographic features, such as rock outcrops or headlands. These models are left as relatively expensive high-poly with their photo-resolution textures intact. The next stage incorporates soft foliage and high-resolution trees. As a New Zealand based body of research here we are at a small disadvantage given that stock tree genus are not native and look well out of place in this context so new tree architecture and leaf structure need to be ‘generated’. Here the interesting point is the tree trunk, branches and so on are native to the application, but the bark and leaves are modified using photo mapping to ensure the species map the native flora perfectly. This characteristic exposes a certain embedded ‘glitch’ to the field where there are a great number of approximations, made to achieve what ‘looks’ like photorealism, as a way to border on reality (Moloney 2003). In the case of say, Tadao Ando’s work, the buildings appear to be made of concrete, but they are in fact not a perfect map, but rather a skin that imitates concrete, but a concrete without reinforcing or a footing, quite simply because it is not needed. And again, it does operate as photography as it is paper thin without any internal mass.

The reality of this case study is that although is looks like photography, and indeed uses aspects of photography the visible content is entirely fabricated. The tree’s leaves are created from many sampled images, but area arranged in a fashion that never existed, or never could exist anywhere except with the RTVE. In summary, the environment presented here, is designed to deceive, is appears a picture extracted from the real world, it is photographic, but it is not a photograph. Moreover, the wet concrete floor has an almost cold feel to it, and the low lighting depicts an almost serene stillness. However, while we have gained the ability to produce increasingly high-fidelity visual environments observation of how people inhabit these spaces reveals a potentially fatal flaw for designers. There is a
tendency to move as deep into the environment as quickly as possible. From an architectural perspective, this spells the death knells for the project, a participant or inhabitant is typically less interested in the building than they are in satisfying a desire to move freely within the digital environment. It can also be observed that the larger and more detailed an environment is, the more likely a ‘virtual visitor’ is likely to venture off exploring the limits of the environment simply to see how large it is, then upon reaching the edge of a given environment, they feel the ‘game’ is complete. As a response to these observations, this research questions: How can we ensure that the RTVE is not a simple extension of traditional Architectural visualisation tools, and how can we ensure that it does not operate like an amusement park attraction?

Figure 1. Photorealistic RTVE. Rock, cement, glass and steel are presented to a degree of fidelity that borders on ‘photographic quality’.

3. Real-Time Virtual Engine (RTEV’s)

The use of computing to help architects and designers visualise their designs prior to construction is undisputed. The CAAD community has undertaken numerous studies vouching for the capacity of ‘real’ and ‘immersive’ environments for nearly two decades within Real Time Virtual Engines (RTVE). Head mounted displays, and higher processing power has allowed for more expensive geometry, materials and shaders to be employed bringing us ever closer to the real world. However at the exact same time steps forward in this area have only rewarded us with increasingly deeper or more complex explorations of ‘the uncanny valley’. In architecture and design, digital visualisations are almost prerequisite, they are certainly compelling, but as this paper argues at times unsuccessfully. Recent trends in digital design have seen an increase in ‘photo-realistic’ impressions of a building or space. While photo-realistic may satisfy descriptions of the form, shape or material it does little to help us understand how the building performs in a kinetic and
often dynamic natural environment, and by doing so true sense ‘immersion’ can never be achieved.

By contrast, the game industry achieves enviable level ‘immersion’ within highly dynamic environments that often forego ‘high-resolution’ or ‘photo-realistic’ representations. This research then questions how might the dynamic capabilities of game engines help produce a more immersive architectural VR environment. This paper identifies that ‘game environments’ hold the advantage through employing a narrative or series of tasks or goals facilitate the offsetting of a reliance on a closeness to reality and enmesh an inhabitant into the ‘game environment’. Architectural visualisation is an extension of hand drawn images, this has evolved into ‘stills’ and finally animation. These are all however based upon static images that may or may not be linked in the case of animation. VR has given designers the ability to walk freely within a virtual environment, and indeed change the angle of view with the quick turn of one’s head. However, unlike game environments, in most cases these environments are more akin to inhabiting a still image than inhabitation of a ‘virtual-reality’ that is changeable, dynamic and responds to our presence.

4. Case Study Two: GUI for Atmospheric Input

As mentioned in the previous case study, the ability to move through the simulated environment is paramount to the discipline of architecture. However, can we move beyond this and if so, what are the ways in which we can achieve such a proposal. This section discusses a suite of Architectural VR environments that employ customised tools to inform the VR space. In the second case (figure 2) study a ‘work bench’ has been developed for the UnrealEngine.

![Figure 2. RTVE with GUI Tool Interface. This environment allows incremental changes to be made to the environment through adjusting a series of sliders located in the top left-hand corner of the screen. DOF, hue, tone and the speed of the environmental factors each participate significantly in the construction of the environment.](image)
This allows the designer to control the characteristics of the Air, Water, Clouds, Precipitation, Environmental Sound, Environmental Lighting, Movement, Animation, Colour, Density, Opacity, Depth of Field, Texture and Point of View via a set of GUI tools or key presses. The outcomes of this approach to design allowed for ‘on the fly’ alterations of the VR environments before allowing ‘inhabitants’ into the VR space. One of the issues with Architects using Game Engines for design is the high time investment required to produce and present work, only to find a small iterative change is needed and then find that the entire environment does not (for whatever reason) work anymore. One key finding from this exercise is that the development of GUI tools allowed for iterative and incremental changes to be made without recompiling or rendering out the environment again. Reports on the in environment GUI system can be found reported elsewhere (De Bono & Moleta 2016).

5. Case Study Three: Toward Digital Ephemera
The third stage of this case study the redirected the GUI inputs for a great number of the atmospheric controllers. Where this example differs from the previous case study is that it stretches beyond ‘representation’ or ‘visualisation’ and connects to ‘live’ data feeds to invoke an irregularity or autonomy for the environment. By organising the VR environment in this way, it starts to suggest an autonomous condition that is less ‘designed’ and more ‘grown’ to achieve a quality that is different each time inhabitants visit. To achieve this variable input the Yahoo weather API (Developer.Yahoo.Com n.d.) and the WUnderground API (WUnderground.APU n.d.) were used to control ten different nodes within the environment. In this final case study (figure 3), if the wind is strong, clouds move more quickly, grasses blow more vigorously. If the wind blew from the NE, the clouds, trees, and soft foliage would respond accordingly. Cloud cover factor was graded to articulate the density in the SkyBox of the environment. Opening the file and visiting at night produces an evening scene with the building being light with artificial lights. The sound is located to specific points in the environment allowing for a more delicate blend of a range of acoustic events.

6. Discussion
To date, one very significant wall has existed which prohibits a meaningful inhabitation of space, and that is the condition termed ‘uncanny valley’ (Coyne & McLachlan 2005). A broad definition of this condition is a mapping of an environment or inhabitant that is ‘close’ to what we would experience through real vision. The largest shocks seem to occur whenever we encounter a natural subject, a tree, a human, and so on. While computing power and software tools have increased significantly, even within the past two years, this still seems to be a hurdle that cannot be breached. It is of note however that perhaps the uncanny valley is not a visual perception issue, but potentially an issue related to a lack of interaction between the ‘self’ and the other participants in an environment, or indeed environment itself. There are I suggest other demerits to VR Space. This is without doubt propensity to move ‘quickly’ through space. Perhaps this is a trained behaviour, whether one is to use WASD, a game console controller or the ‘wand’ for
HTC Vive of other, one of the greatest limitations to a meaningful inhabitation of space is this ‘learned’ behaviour to inhabitants virtual space at great speed. This occurs not only at the hands of skilled teenagers worldwide but any CAD operator who might guide a client or consultant through a BIM model at bullet speed. This is however slightly contrasting given that some of the greatest buildings are regarded to foster a thought provoking and sustained presence in a particular area of space (Zumthor 2006; Tanizaki 1977), such as Tadao Ando’s Church of Light; Frank Lloyd Wrights- Fallingwater; Ludwig Mies van der Rohe - German Pavilion or Peter Zumthor’s - Baths at Valls. Each very different buildings, but buildings none the less are typically heralded as structures of extremely refined elegance. It then asks the question? Would we consider such structures as significant if we were to experience them first hand via a segway at full speed that never permitted pause. Indeed, by the very nature of the RTVE that drives a great many of the virtual environments movement is accentuated, over pause.

If we were to imagine then, a more refined VR space, I believe it would be one where pause might gain an equal footing with movement, were an observation of a designed space might provide an inhabitant just a sampling of the characteristics we hold so dearly in architecture. If I were to unpack this condition a little more the RTVE or indeed ‘Game Engine’ was not designed for the architectural discipline. It is a toolset to allow the interactive media industry to produce games. By investigating games if only briefly we uncover fundamentally that each has a task set that encourages ‘player’ participation by moving either deeper into the environment to uncover increasingly difficult challenges or indeed amble deeper into a narrative. As technology has developed we have seen an increase in the visual ability of such tools develop rapidly, however, the basic structure remains largely unaltered.

If we return to the earlier statement, why do we accentuate movement over

![Figure 3. RTVE employing weather API’s.](image_url)
pause in VR, I believe that it is due to the nature of our toolset inherited from the
game or interactive media industry. Then how might we combat this in the terms
and on the basis of the architectural discipline? I propose that we can achieve
this through the notion of a ‘digital ephemera’. Why would a digital ephemera
aid a discipline so grounded in the real? The writings on atmosphere by Mark
Wigley describe some of the tantalising and visceral characteristics of architecture.
Sensuous and stirring gaseous and ever changing bodies of light, humidity, air
pressure, and trajectories. Fading light, increasing levels of heat, reverberating
acoustic events that shake and impart influence on the human body (Wigley 1998).
Evoking the most exciting and bodily descriptors, architecture is now retrieving
some of it’s most wonderful characteristics. The ‘ephemera’ of Architecture is
something that can never be captured in a fixed frame, and therefore the wonder
of the discipline can indeed be more accurately described or even explored and
embellished within a VR space. Do we need to develop new tools to achieve this,
I believe not. Again, presently the most powerful tool we have is borrowed from
another industry, and therefore it is likely very important to return to this industry
to refigure or mine some of these moments of ‘ephemeral’ success.

- The sands of ‘Journey’ (That Game Company n.d.)
- The slow and fluid movement altered and buffered by the wind in ‘Flower’
  (That Game Company n.d.)
- Humidity made palpable in ‘Limbo’ (PlayDead n.d.)
- The ever-changing acoustic environment of ‘Child of Eden’ (Ubisoft n.d.)

The above titles are a fairly eclectic set of references. None are particularly popu-
lar, and despite their high degree of craft, they fall cleanly into the ‘indie’ category.
However, from an architectural perspective, each of these titles present something
very important to the field of architectural design, if not something very ‘desir-
able’. It is also of note that these are effectively quite slow experiences, a great
change to many interactive environments is that the designers of these experiences
have gone to great lengths to ensure that the inhabitant is allowed a considerably
long term to inhabit these spaces. We have here, in an entirely different, but not
altogether unrelated industry a set of examples of ‘how to design a meaningful
inhabitation’ of space. This is outstandingly useful if we return to designing space
in the virtual as we have now a reference to designing a structure as a static ob-
ject in a fixed environment, but perhaps move toward a designed space within a
much larger kinetic environment, or ecology if it were. The fleeting, cyclical, dis-
sipating and retreating characterisation of the virtualisation of architecture may be
improved greatly by considering the notion of ephemera. The terminology above
mentioned, however, a ‘digital ephemera’ and again, this is as key as the current
climate we design within is laced with computers, and by operating in this world
we find the ability to connect again with the physical. SMARTCities, Wearable
Tech, IoT, Smart-Spaces to name a few are increasingly allowing for greater trans-
mission of data, and by doing so may indeed allow aspects of the real to feed back
into the virtual world that we use to inform our designs.
7. Conclusion: Towards Real-Time Events in Architectural VR Environments

Where the RTVE can allow for the designer to control the outputs, or events in an organised manner, much like a film director, however one of the more interesting developments is the ability to tap into streaming data sources to place new inputs into the VR environment. What this allows is, similarly to a real environment, and indeed a MMORPG is a space that upon returning too, is entirely different. Perhaps, one of the deflating characteristics of many virtual environment is the simple characteristic that one visited, a repeat is not required, or indeed hinted at being a probability. While this is achievable through simple animated events, tapping into live data permits a more significant inhibition. What then are the benefits of virtual space and how do they impact upon the activities of design. Toward the beginning of this paper we ask, “do the virtual spaces we craft and form not bring about new understanding of architecture?” It is certainly a provocative question, and one with an answer that is only being touched upon. The first step to tackling this question is understanding the last half of the question, by defining, indeed, what is architecture. It is certainly a field that can be defined as the activity of designing forms and spaces, assembling materials in such ways as to influence inhabitation. In the loosest of definitions, this seems an acceptable fit. If we dig a tiny bit deeper, we uncover a world of CAAD, BIM, Generative Problem Solving, Advanced Manufacture which have all become inexplicably linked to the discipline, yet they support it, or refigure it in some way. I question then, architecture is perhaps a sound way to describe an approach to the creative activity of designing, or refiguring? Such a descriptor, as liberal as it sounds, however, is particularly powerful when located in relation to descriptions of space as found in VR environments. VR space allows and permits an inhabitant to be guided and altered in the way they inhabit space. Although architectural visualisation aims to represent the key characteristics of a particular building, we find that it often falls short due to the heavy visual basis many common tools employ. In this body of work, through the use of the RTVE a wider range of sensations are touched upon to simulate an environment with a higher degree of detail. The outcome does not focus solely on visual quality, but also on a rich, varied and kinetic environment.

The conclusion drawn from these examples is that when virtual inhabitants are presented with a greater variety of inputs, a significant change occurs in inhabitant behaviour. The inhabitant is less likely to explore the countryside, and will in most cases stand completely still in the environment - watching, listening and by great contrast, waiting to see what will eventuate in the space. Pausing between walls designed to focus a view, or simply observing clouds throwing shadows across a meadow are events that require patience and indeed a might indicate the success of a designer to guide their inhabitants activities within a space. This shift begins to signal a considerable culture shift in how an inhabitant begins to explore and come to understand a virtual space. The addition of relatively subtle details in these cases have countered the ‘game-like’ desire to race to the limits and instead are willing to wait long enough explore some of the characteristics that the discipline holds most highly.
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References