Tangible and Intangible Digital Heritage

Creating Virtual Environments to Engage Public Interpretation

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This research developed an immersive, multi-dimensional Virtual Experience of the `Gordon Wilson Flats', a Modern apartment block constructed during the 1950s in Wellington, New Zealand. The project explored methods to virtually reconstruct the spatial qualities of the building and document the flats in both their current and original states within the context of Wellington City. This digital heritage project documents both the tangible and intangible characteristics of the building to inform public discussion focused upon the flats. This approach was in an effort to capture the effect of time on the buildings tangible elements, and with the addition of oral histories, develop a narrative which is intended to facilitate architectural understanding and heighten engagement within the immersive virtual environment. This paper presents a digital methodology for the creation of a digital heritage experience with the purpose of engaging and informing public discussion.

Keywords: *Digital Heritage, Virtual Reality , Immersive Environments , Modern Architectural Heritage, Digital Methodology*

INTRODUCTION

The perception of Modern architectural heritage is defined by an unawareness of the period's architectural and historical origins. As a result, the technical and aesthetic innovations of Modernism, and the times of social change these advances represent are unrecognised. Instead, degradation of these buildings caused by unforeseen issues with experimental techniques and materials creates concern among the public. Today, these buildings are perceived as an eyesore within an urban landscape (Guillet 2007).

Immersive experiences provide an opportunity for public engagement with architectural heritage (Mortara et.al. 2014). They facilitate an experiential understanding of historically significant sites which are not accessible, however of interest to the public (Champion 2008). The documentation, and subsequent representation of Modern architectural heritage within virtual environments, results in the dissemination of the experience of buildings originating from this architectural period. The virtual reconstruction of these buildings thus provide a means

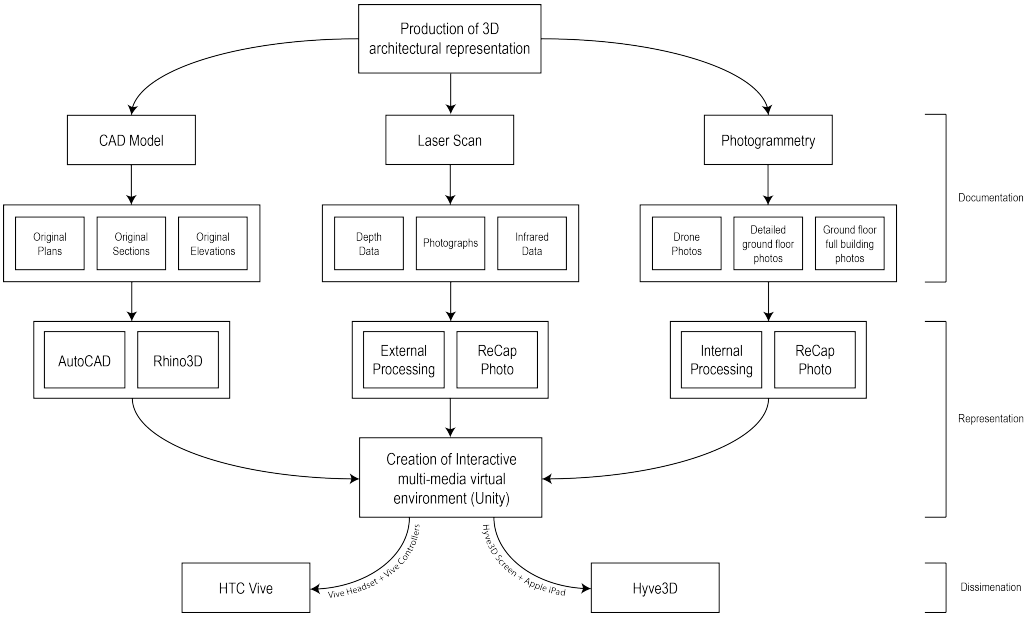


Figure 1
Methodology outlining the documentation, representation and dissemination of an interactive multi-media virtual environment

to enhance and engage the public's interpretation of heritage, contextualising the heritage in relation to the present (Affleck and Kvan 2005). As a result, the perception of modern architectural heritage - created only by a building's current state of decay - is informed by the of information about the heritage within an immersive Virtual Environment. The contextualisation of Modern architectural heritage can be achieved through gamification applied within the context of virtual heritage environments, towards the creation of a virtual experience of Modern architecture. This considers the reconstruction of heritage within the framework of a game, leading to greater engagement, and thus value derived from the experience. This is achieved through interactive storytelling, to engage experiential interaction with digital heritage (Malegiannaki and Daradoumis 2017). The methodology of a digital heritage experience follows three stages: documentation, representation, and dissemination (Rahaman, Hafizur and Beng-Kiang Tan 2011).

The documentation stage aims to record the tangible and intangible characteristics of the architecture. This is in an effort to recreate the context for the deterioration of this architecture, the documented characteristics of the building are to be considered over a buildings lifetime. In the representation phase, the complexities of the tangible and intangible are to become explicitly connected. In our case, to produce an experience of modern architectural heritage. This communicates the evolution and deterioration of the period of this architecture, for dissemination within the narrative of the game - which can be experienced through various virtual realities.

The aim of this methodology is to facilitate the interpretation of architectural heritage, resulting from the contextual information about the building provided to the viewer within an immersive environment. The range of information given relating to the tangible and intangible, and the freedom of virtual

environments, allows for various interpretations of the building and its heritage significance. Where the interpretation of the resulting disseminated experience depends on the ideology and background of a user, the virtual environment leads to an opportunity to inform public perception of heritage (Rahaman, Hafizur and Beng-Kiang Tan 2011). From which authenticity is created by a range of interpretations the virtual medium provides (Aydin and Schnabel 2015).

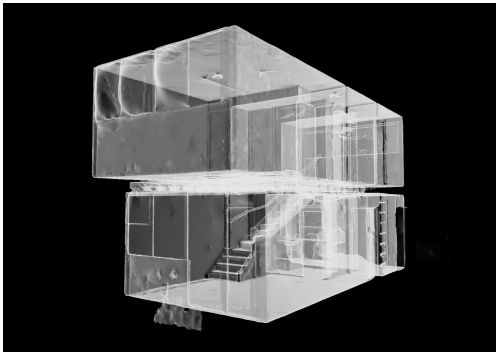


Figure 2
Output of completed laser scanning, represented as point cloud data.

CASE STUDY AND METHODOLOGY

Following contemporary criticisms of Modern architecture amongst the urban landscape, this paper will investigate the case of the 'Gordon Wilson Flats', a modern apartment block constructed during the 1950s in Wellington, New Zealand. It will follow the process of the previously discussed theoretical methodology, to redefine this within the context of a digital methodology (figure 1).

DOCUMENTATION

The documentation of the tangible and intangible aspects of the Gordon Wilson Flats. This section outlines the methods that were undertaken in order to gather information to implement inside the Virtual Space. It includes CAD modelling, laser scanning and photogrammetry as means of gathering information.

CAD Model of the Gordon Wilson Flats

To begin this project, we took original plans from the 1950s, and recreated these in *Autodesk AutoCAD*. These recreated plans had to be identical to the original drawings in order to ensure that all the floors lined up with each other in the 3D CAD model. A problem that arose around this was that the original plans were measured in feet and inches, whereas *Rhinoceros3D* measures in meters and millimeters. A precise conversion had to be made so that we could ensure that all of the floors were the same size. By recreating these drawings in AutoCAD, it allowed us to have the plans to scale in DWG format, and then export them from AutoCAD into Rhinoceros 3D.

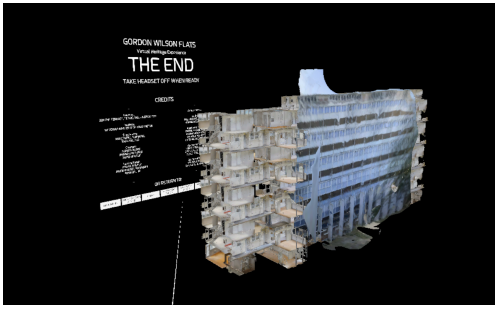
From here, we began extruding walls and risers to create each floor of the apartments. Ten floors were created - each one eventually being stacked on top of another to create the full apartment block. Once these were stacked on top of each other, many touch ups had to be made to create a detailed exterior model. Interior models of each of the apartments were created using the original drawings and photographs from a 2017 site visit. These interior models had the details of the apartments right down to the balustrades and door knobs. Of the three people working on this project, we were each tasked with the modelling of one of these apartments.

A separate model of the whole apartment block was also made in less detail than this one. This model only had the exterior of the building, along with internal walls. The use of this model was an interactive modular apartment block, in which the user could drag out the separate apartments and begin to understand how the construction of it actually works by interacting with the model.

Laser Scanning with a LiDAR Camera

The laser scanning (Figure 2) for this apartment was done using a state of the art Matterport Pro 3D laser scanner using LiDAR technology. This device incorporates three different lenses, each taking in a different piece of data. These three lenses are an infrared camera, a normal camera which takes photographs

in order to texture the model, and a camera which calculates how far an object is away from the camera. In order to get enough detail in the 3d model, around 50 or 60 scans have to be taken of each apartment. This information is then sent away to an external company for processing. When they are returned, they come in the form of point cloud data and separate texture maps. We are then able to take this information into *ReCap Photo* and edit it further if necessary. When these 3D models are placed in the virtual reality experience, they reflect the current state of the flats, and thus lets people explore them at a 1:1 scale.



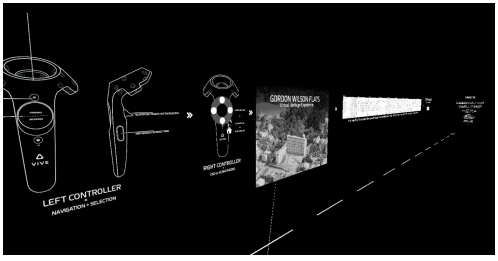


Figure 3
Photogrammetry gives a 1:1 realistic impression of the current exterior condition.

Photogrammetry of the Gordon Wilson Flats

The process of photogrammetry is similar to the process of laser scanning. It is a way of making measurements from photographs, and as a result, creating a 3D model from the photographs. We began the process by taking photos of an exterior or interior aspect of the flats. Depending on the size of the object we were photographing, a range of 20 and 100 photos were used. Once we took all of the photos, we processed them in ReCap Photo to create a detailed 3D model with realistic textures (Figure 3). Drone flights were also used to take photos for the photogrammetry of the building. With around 1000 photos, this allowed us to create a 3D model of the entire exterior of the building in its current state. Since we were only able to process a maximum of 100 photos at a time in ReCap Photo, we had to make a number of separate models and then stitch them together in the software to create something that resembled the full building.

REPRESENTATION

The collection of tangible and intangible documentation, represented within virtual space. This section outlines the method for creating the virtual space in which the user interacts with.

Creating the Virtual Reality Experience in Unity

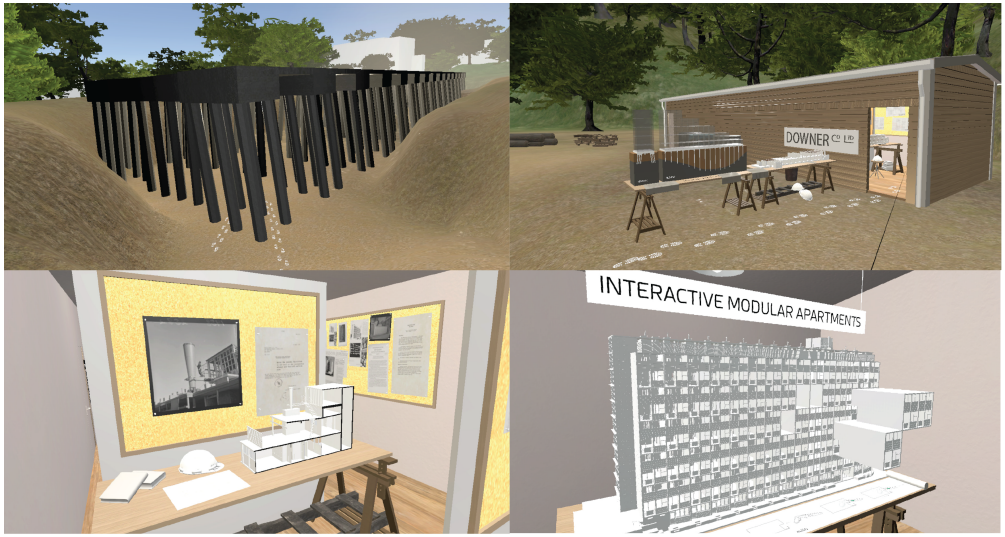
The game engine, *Unity*, was used as the platform for creating our virtual reality experience. Using Unity gave us the freedom to import 3D models, download premade assets from the Unity asset store, and use C # programming language to code both the controllers and the environment around the user. This programming allowed us to be able to switch between different scenes using the controllers that the user navigates the game with. It makes for a more autonomous and continuous experience through the history of the flats.

Introduction Scene

In the introduction scene of the experience, we first greet the user with a basic description of how the controllers work and what the different buttons/trigger do (figure 4). We allowed these buttons / trigger to do different things by using C # and applying the codes to the controllers in the Unity *SteamVR* plugin. We then draw people down a small path in which they can see old construction drawings of the flats from the 1950s. This whole scene was put together inside Unity itself using different tools inside

Figure 4
Introduction scene of the virtual reality experience, outlining instructions on how to use the controller and basic information about the flats.

Figure 5
This scene outlines and details the construction to introduce the user to the beginnings of the Gordon Wilson Flats



the game engine. Once they reach the end of this path, the user is told to press the 'begin' button, taking them to the construction scene of the experience.

Construction Scene

This scene consists of a 1:1 remodelling of the piling system used for the building, along with a construction office with small scale models of the flats outlining the construction process (Figure 5). These models were created in Rhinoceros 3D using original drawings of the flats, along with photos from a 2017 site visit. Inside the construction office, along with the small scale models, there is also a variety of information surrounding the construction of the building. This information includes letters and newspaper articles, applied in Unity itself in order to give a deeper understanding of the construction process. At the end of the office, the interactive model allows the user to pull the individual apartments in and out of the concrete walls and floors. This gives people a greater understanding of the modular system that the flats consist of and how the apartments were constructed.

Lobby / Apartment Scenes

Once the user has exited the construction office, they are transported to the lobby of the Gordon Wilson Flats. In this lobby scene, the user is able to experience the space in a variety of ways. Using C # programming, we coded the controllers so that the user can switch between the built CAD model, and the laser scan that we took of the space. This interactive way of being in the space gives the user more autonomy of how they would like to perceive the building. From this scene, there is also the option to go to the interior apartment scene modelled at a 1:1 scale. In the apartment scenes, they also have the ability to switch between the CAD model and the laser scans taken of the interiors (figure 6). Along with this mobility between scene types, there is also the ability to turn furniture on and off and understand what the building was like in a variety of different states.

Flythrough (Original colours and laserscan / photogrammetry)

The flythrough scenes that we incorporated into the end of the experience gives the user the ability to

Figure 6
The representations created by laser scanning, photogrammetry and 3D modelling presents contrasting views for the user.

fly around the building at a 1:1 scale (Figure 7). The two flythrough scenes include a CAD model of the entire building in original colours from the 1950s, and a laser scan/photogrammetry model showing the building in its current state. The CAD model was modelled in a very high amount of detail, as when flying through this scene, the user has the ability to get very close to the building. This means that if anything seemed out of place or not detailed enough, it was very easy to tell. When the laser scan/photogrammetry scene is first entered, only the laser scan data of the interior of the apartments is able to be seen. The user is then able to turn on and off different pieces of exterior photogrammetry data, understanding how each piece of this data fits together around the rest of the building. The way that this fits together provides a puzzle-like interface while maintaining a game environment necessary for the informing of the building's heritage significance.

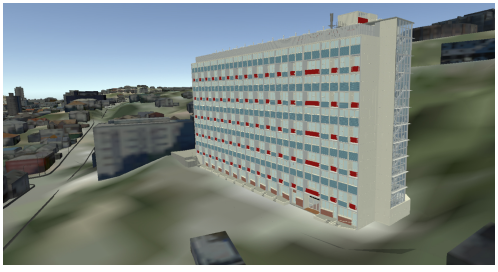


Figure 7
Building in its original condition as represented with a CAD model. This is experienced at 1:1 scale within virtual reality.

DISSEMINATION

The interaction of the user with the virtual space. This section outlines the different programs that were used to immerse the user within the created virtual space and the different experiences that these programs can create.

HTC Vive

Experiencing the Gordon Wilson Flats through immersive virtual reality with the use of a head-mounted-display proved to create a variety unique experiences of the environment per individual (Figure 8). This technique gave each viewer the opportunity of freedom to explore any particular area of the environment they wished to see with small guidance from the curator's scene structure. This allowed them to derive their own interpretation of the building and its context. An experience such as this turned out to be quite isolated as there in no one appearing to be in the same virtual environment as the viewer, the viewer sometime seems uncomfortable being put on the spot to experience this, depending on their personality. This caused for them only spending a short amount of time within the spaces compared to other more confident viewers.

Hyve3D

This type of presentation presents an immersive 3D Virtual Environment without the need to wear any virtual reality headsets and trackers. It is designed to be lightweight and portable (Figure 9). It is designed for local and remote collaboration of digital models with real-time sketching. The Gordon Wilson

Flats various exterior photogrammetry models were imported into the *Hyve3D* as OBJ files along with textures and material definition files. This allowed for collaborative semi-immersive viewing of some of the curated data, rather than an isolated fully-immersive virtual reality experience with the *HTC Vive*. This, as a result, invokes engagement with multiple people at one time, in the same space. Members of the public, therefore, experience the flats within social virtual reality, which provides a collaborative medium to encourage discussion (Schnabel, Aydin, Moleta, Pierini and Dorta, 2016). The result is an informative experience that provides a collaborative medium to encourage discussion of interpretations during the experience. In order to formulate judgments about the heritage significance of the Gordon Wilson Flats and the building's place within Wellington City.

Figure 8
Singular experience to form an individual interpretation of the heritage.

Figure 9
Social Immersion within the Hyve3D allows for interaction with the heritage.

CONCLUSION

Following the contemporary perceptions of Modern architectural heritage, the purpose of this research was to create an experience of the Gordon Wilson Flats, in order to engage and inform public discussion surrounding the flats. This paper has presented a digital methodology for the virtual recreation of modern architectural heritage. This methodology highlights the documentation, representation, and dissemination phases in the creation of an experience to encourage engagement with the context of Modern architectural heritage. The experience has been achieved with the use of digital tools. Within this process, the documentation collected both tangible and intangible histories of the 'Gordon Wilson Flats'. Following this, we collected information about the architecture to be represented within reconstructed virtual environments. These environments were depicted using the methods of CAD modelling, laser scanning and photogrammetry. They juxtapose conditions of the flats over time and therefore highlight different states of deterioration - contributing to a narrative of decay. The dissemination of these environments, within the creation of a gaming context, allows for greater engagement with the architectural heritage. Furthermore, different dissemination modes of immersion provide different experiences, and hence new interpretations of the architecture and its significance. The dissemination, therefore, allows for access to an otherwise inaccessible building. In that, the representations lead to novel interpretations about the history of the flats - these inform the perceptions relating to the decay of the Gordon Wilson Flats as Modern architectural heritage. Ultimately, this leads to contextualised public perception, hence informed discussion and decision making.

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