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Virtual Representations and Imagined Reconstructions of one of Australia's most significant Bark Painting Collections

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Abstract

Repatriation of museum materials to their originating cultures and communities remains an ongoing process, often marred by controversy but also the limited resources of communities to house vast collections of often fragile cultural heritage. Using photogrammetry and other digitisation methods to make museum materials remotely available does not replace repatriation but these digital simulacra can become the anchors for immersive and interactive virtual reality environments to provide communities with alternative and powerful platforms for cultural engagement. The ease with which large collections of museum materials can be digitised with photogrammetry and the growing capabilities of standalone virtual reality headsets to render complex models and environments enables immersive experiences of museum collections to be brought directly to remote communities like Gunbalanya in Australia's tropical north. Trials of these virtual experiences in Gunbalanya based on a more than one hundred-year-old bark painting collection at the Melbourne Museum have demonstrated the strong emotional reactions immersive and interactive cultural virtual reality experiences can produce, bringing about both fun and nostalgic reflection. Constructing these virtual experiences also challenges conceptions of scientific authenticity in archaeological digital reconstructions of the past, particularly where inclusion of Indigenous ontologies is necessary to produce a truly authentic cultural experience.

1. Introduction

One of the most significant Aboriginal art collections ever formed in Australia was created by artists in Oenpelli (now Gunbalanya) between 1912 and 1922 (see location Figure 1). This collection of over 160 paintings on bark was commissioned by famed biologist and 'Chief Protector of Aborigines' in the Northern Territory, Baldwin Spencer. He was assisted in this endeavour by buffalo shooter Patrick 'Paddy' Cahill who had established the Oenpelli settlement with local Traditional Owners in 1910 (Mulvaney 2004; May et al. 2020). As Spencer was Director of the National Museum of Victoria in the early 1900s when the collection was made, the bark paintings were sent to Melbourne and today reside in the Melbourne Museum (Taçon et al. 2023). To Spencer, the collection represented an artistic tradition yet undisturbed by external forces, something of great ethnographic value.

Taking them altogether, the bark and rock drawings of the Kakadu, Geimbio, and Umoriu tribes represent, I think, the highest artistic level amongst Australian aboriginals, with the possible exception of the Melville and Bathurst Islanders, whose art, however, shows indications of the influence of some culture outside that of the Australian Continent (Spencer 1914: 439).

The appreciation of Aboriginal bark paintings as 'art' rather than ethnographic object had not yet emerged and this collection was largely considered evidence of Aboriginal belief systems that were destined for extinction (e.g. Spencer 1914: 41). Ironically, Spencer's commissioning of paintings on portable sheets of bark at Oenpelli ignited a new art industry in the region and led to the development of a significant international collection and a market for western Arnhem Land bark paintings which still exists today (e.g. Goldhahn et al. 2021; see also Poll and Harris 2021; Taylor 1996, 2006).

Figure 1. Map showing the locations of Gunbalanya and Melbourne Museum. Adapted from ESRI.

In 2021, we began a new collaborative project 'Art at a Crossroads' to explore the history of the Gunbalanya Spencer-Cahill collection, to help community to re-connect with the paintings, and to deepen our understanding of and to give voice to the artists behind the collection (Beach 2022; Goldhahn et al. 2021; Taçon et al. 2023). We have drawn upon archival, anthropological, archaeological and oral history evidence, to achieve these outcomes. Key to this study is the expertise of Aboriginal artists working today in Gunbalanya. Yet, the fragility of the now more than one hundred-year-old collection limits its availability to travel from Melbourne to the community for viewing, thereby, restricting the ability of the community to engage with the collection. As a result, the decision was made to digitise the collection using photogrammetry, capturing the fine details of bark painting shape, texture and, of course, the artistry.

Photogrammetry is now a valued tool in the belts of both archaeologists and GLAM institutions for its ability to accurately record and disseminate 3-D models of tangible cultural heritage. Although a range of commercial and bespoke 3-D model hosting platforms now exist, such as SketchFab, the diminished quality associated with the constraints of webhosting models and the object focused nature of the method propagates a view of material culture which diminishes the wealth of contextual information in which objects are embedded.

As archaeologists, this contextual information is frequently of greater scientific value than the artefact itself but the same can also be said of how people generally appreciate the authenticity and cultural value of an object. This desire for contextual richness has often been cited in support of repatriation efforts like the Parthenon Marbles, with poets and politicians alike arguing that they can only be truly appreciated under Attic light (Beresford 2015:4). But as Beresford (2015) contests, repatriation is only a lateral movement in space, it does not necessarily restore the conditions unique to the past, which are of equal if not greater importance to producing this contextual richness. Many methods have been applied to material culture collections to elicit a sense of this temporal context, with Spencer (1922:136) himself using a life size diorama in one of his exhibitions to achieve this. With the production of digital copies from photogrammetry a range of new possibilities have emerged for exploring the restoration of the context in which objects were once situated. Virtual Reality (VR) presents the most compelling platform to explore this as it allows users to have embodied experiences with these digital copies within an infinitely customisable virtual environment and in ways not possible in real life, all only limited by the computational power of the VR system. But in pursuing this medium and all its possibilities, old questions remain for how archaeologists can maintain intellectual honesty while still producing media which is engaging and valuable to communities (Gillings 2001).

Within this context, the Bark Painting VR project has explored two key questions. Firstly, does the virtual reality application provide improved accessibility to the collection for the community and how can community feedback inform future efforts to ensure access to cultural heritage? Secondly, from user experiences, what can be said of how virtual reality facilitates embodied authentic experiences with cultural heritage and past contexts, and how does co-creation, cultural knowledge and archaeological methods inform this process?

2. Methods

Melbourne Museum currently houses 152 bark paintings from the Spencer-Cahill collection. The first digital data collection period was 18-20 July 2022, which resulted in 31 bark paintings recorded using both photogrammetry (Canon 6D mark ii with 35mm lens) and laser scanning (Leica BLK360). The centenarian bark paintings were too fragile to be turned over, so only the painted side was accessible. This was not an issue because the barks are very thin, around 1 cm, and it is fair to assume the back of the bark follows the shape of the front in even thickness. In order to minimize impact from handling, the barks were often left in their archival boxes while being photographed and scanned. Therefore, there was some difficulty recording the edges of the bark that were touching the sides of the box or the white foam pluds used to secure the barks in place (visible on Figure 2).

All images for photogrammetry were collected in jpg and raw formats using a tripod following the procedure outlined in Jalandoni et al 2018. Between 14 and 70 photos were taken per model depending on their size, which could be up to 2.94 metres in length. Each image had approximately 60-80% overlap with neighbouring images. An Xrite ColorChecker Passport Photo was used for the potential to colour correct every image. A side-by-side comparison of the 3D models created from colour-corrected raw images versus the plug-and-play jpgs produced from the camera, revealed the colour difference was minute (Figure 2). The extra effort of colour-correcting and generating additional large raw files for 152 models was deemed unnecessary for the objectives of this project. However, the data is available should there be a need for colour corrected images in the future.

Figure 2. Comparison of uncorrected (top) and colour corrected (bottom) 3D models.

It was determined that the photogrammetry model sufficiently met all our needs, so for the second round of collection the BLK360 was not used. Structured light 3D scanners (Artec Leo and Spider) were trialled, but again they would have increased data collection time and the difference in quality from photogrammetry did not justify the extra time or cost for this project. The remaining 121 bark paintings were recorded 15-31 January 2024 using a DSLR camera. The photogrammetry software used was Agisoft Metashape Pro v2.0.0. The end result was a photorealistic 3D model of the painted side of each bark, with an average spatial texture resolution of 3 pixels per millimetre.

Initially, the primary consideration was what VR headset would host the program? The deciding factor was accessibility relating to availability of computational infrastructure. Personal Computer Virtual Reality (PCVR) works best with a wired connection to a computer with a mid to high range graphics processing unit (GPU), something which would be more difficult to facilitate in Gunbalanya. Furthermore, use of PCVR is further discouraged by the set-up steps required to run any application by users unfamiliar with the system. By contrast, standalone VR platforms, such as the Meta Quest series, have several benefits. Firstly, they allow users to move freely and without concern for cables getting tangled, this is further facilitated by large indoor spaces available at Gunbalanya that are well suited for this kind of activity. Secondly, being a standalone platform specifically for running VR programs, very little set-up is required compared to PCVR. This makes the process of starting a VR app, such as the one developed here, much easier for novice users. Lastly, standalone VR platforms are comparatively cheap when considering the Meta Quest series, not requiring investment in a desktop PC that could comfortably run PCVR applications. This comparison becomes even more favourable when multiple concurrent users are considered, as additional standalone headsets are cheaper and easier to manage compared to multiple PCVR set ups. With all of this in mind, the Meta Quest 2 was selected as the platform of choice, with program development being done in the Unity3D Game Engine

Given these apparent benefits to using the Quest 2, it is important to note the major drawback compared to PCVR options. The internal hardware of the Quest 2 and later iterations is effectively a specialised Android smartphone, meaning its computational power, particularly its ability to render video graphics, is very limited compared to PCs with dedicated GPUs. To quantify this the entire design and development process for this project was limited to 750,000-1,000,000 triangles rendered in a scene and a few hundred draw calls. Triangles are a basic unit of 3-D models, made up of three vertices which are coordinates in 3-D space. As noted previously, the 3-D models of the bark paintings averaged between 250,000 and 1,750,000 triangles each. Draw calls added an additional limitation. Draw calls refer to the commands given by the central processing unit (CPU) to the GPU. In practice, this limits the number of 3-D models which can be rendered at any one time in the user's view. While the number of bark painting models would not exceed the draw call limit, it limited the amount of environmental assets which could be placed in a scene, like grass, rocks and trees, as well as additional features like animations and physical interactions.

To overcome these limitations several steps were taken relating to the bark painting models. First, the bark painting 3-D models were decimated in modelling and animation software Blender. Models were decimated to two levels, one at a higher detail (70,000-120,000 triangles) and one at a lower detail (>16,000 triangles). Despite this dramatic reduction, visual fidelity loss was minimal and not perceived by users (see Figure 3). This was aided by both preservation of the texture resolution (8,192x8,192) and the relatively flat geometry of the bark paintings. Decimated model fidelity could be further improved by manual UV mapping, that being the way a 2-D texture is applied to a 3-D shape, but because of the considerable time investment needed and little return, it was not undertaken in this case.

Second, the purpose of creating a high and low detail version of each bark painting was to utilise the Level of Detail (LOD) function in Unity3D. This dynamically shifts between different versions of a model based on user proximity to the model. Consequently, computational resources were not being wasted on rendering the high detail models when there was no discernible difference to one with an order of magnitude fewer triangles e.g. 100,000 for a high detail model and 10,000 for a low detail model. Lastly, the computational load of the models was further reduced with Occlusion Culling which instructs the program to load and unload models based on the user's vision, meaning that models not in the user's vision are not being actively rendered and drawing computational power.

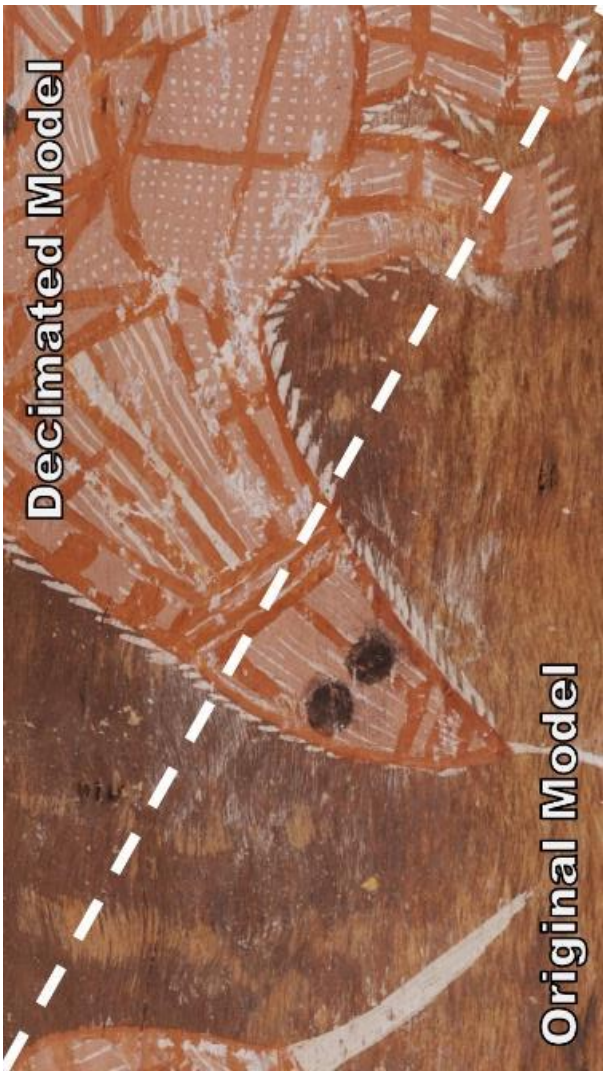

Figure 3. Comparison of original and decimated 3-D models of one of the bark paintings.

Preparation of the bark painting models, while time consuming, was a relatively simple workflow directed by computational limitations, but providing them a virtual environment to place them in was much more challenging. Initially, a virtual gallery in the style of many other VR heritage and museum projects was considered as it would be quick and easy to create while also being considerate of the computational limits of the platform, but it offered little difference to the way in which these bark paintings had been displayed over the last century at real-world museums and galleries. Therefore, the decision was made to try to place the virtual bark paintings into what can be nebulously termed as a traditional context. This traditional context was imagined as a bush camp in the style of those recorded in the 19th century in western Arnhem Land. Photographic records of these camps show bark paintings being incorporated into the structures (see Jelínek 1987:109-110) and Spencer's own retelling of his collecting indicates their presence in residential camp structures near Gunbalanya (Spencer 1928:793; see also Spencer 1922:128). Therefore, these camp structures containing the bark paintings were to be the focus of the virtual environment, with vegetation, rocks and water acting to both fill and contain the interactable area. The design of the bark structures was further supported by illustrations from Memmott's (2022:161) *The Aboriginal Architecture of Australia*.

The environmental assets were the most challenging aspect of the development process. Vegetation, in particular, does not lend itself to computationally constrained virtual environments because organic shapes and colours are variable in both their textures and geometry. Because of this, repeating textures and flat geometry on models are very apparent to users and can detract from the believability of the virtual environment. Furthermore, environmental assets which would be believably present in a recreation of an Arnhem Land bush camp are not abundant in online 3-D asset collections, necessitating some custom model creation. Custom model creation was done in Blender to create the trees, termite mounds, bark shelters, the campfire and some of the rocks.

Initial versions aimed to have the bush camp situated in an open environment (Figure 4), but it was soon apparent that with the computational constraints of the Quest 2 this design could not be adequately populated with environmental assets to make it reflect the dense vegetation present in the Arnhem Land bush. The solution to this was to wall in the virtual space to reduce the area which needed to be filled with environmental assets. The early version of this new confined area was heavily critiqued during initial user testing due to inadequate environmental assets and generally poor design. To resolve this and to remain faithful to the Arnhem Land environment, sandstone cliffs were used to constrain the interactable area (Figure 5). The new playable area was now contained and visually rich with a sense of scale maintained by the imposing cliffs.

Figure 4. Early version of the virtual environment with water features and more vegetation in Unity3D.

While the visual aspects of the virtual environment are crucial, they served as the wrapper for the real purpose of the VR medium, which was to allow interaction between the user and the bark paintings. The conventional means to interact with virtual environments come via the head-mounted-display six degrees of freedom, that is the VR headset translating head movements, and one controller for each hand. The Quest 2 also offered what was at the time experimental hand tracking interactions which functioned by the head-mounted-display's cameras tracking the user's hands and translating them into the virtual environment. This presented some clear benefits over using controllers. First, users unfamiliar with controllers would not have to learn the functions of various buttons, something which can act as a barrier to entry and adversely impact user immersion. Second, the hand tracking allowed for more natural interactions with the virtual environment, with users able to simply reach out and grab the paintings. Using the hand tracking also presented some design issues. First, locomotion, that is the user's means to move around the virtual environment, is typically tied to the controllers. While locomotion methods using hand tracking are possible, it is often equally if not more difficult for users to learn than the same method on the controllers. Secondly, the controllers offer a degree of tactile feedback through pressing buttons and vibrations, something that is missed with hand tracking. Lastly, while the quality of hand tracking is improving with hardware and software iterations, during this stage of development it was still prone to issues such as not registering interactions and losing track of the hands.

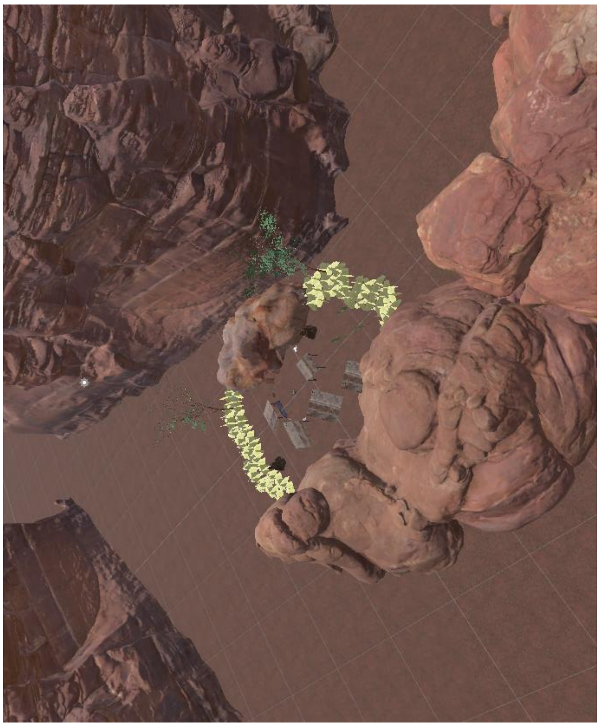

Figure 5. Aerial view of playable area in the version used in session two in Unity3D.

Fortunately, controllers and hand tracking could be seamlessly alternated between, allowing users to adapt to their own desires and the setting. For example, in a confined space or seated position, controllers were desirable to facilitate virtual locomotion, alternatively if an open space was available virtual locomotion could be achieved by the user walking around the real-world space.

This workflow, summarised in Figure 6, was quite simple. It requires limited movement of data between different software and utilises very well-established development progression. In combination with the range of free tools and tutorials associated with the software used, it is an accessible approach appropriate for archaeologists with some technical software experience and ample time.

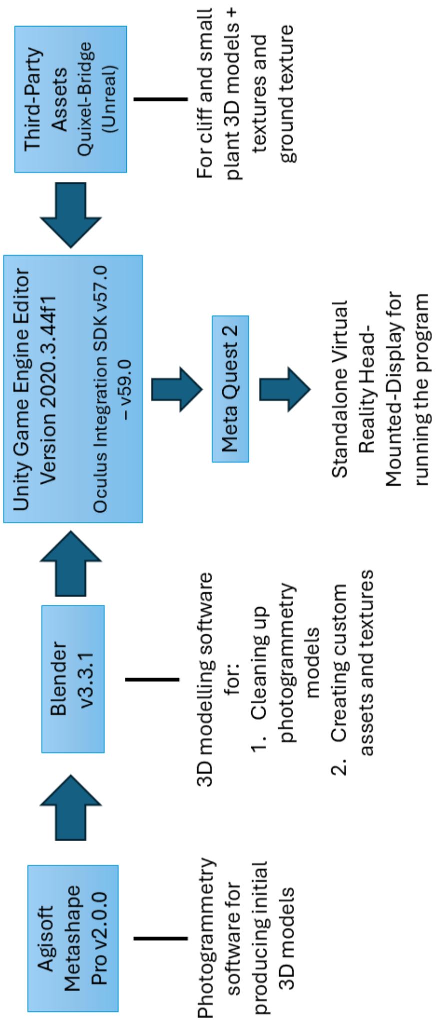

Figure 6. Digital Pipeline Flowchart

3. Results

Two community demonstrations and feedback sessions took place in August and October of 2023. At each session community members were invited to try the VR experience and provide their feedback on it. At the second session community members were also video recorded and interviewed to gather more detailed feedback on their observations and feelings relating to the VR experience. At the first session three users used a combination of controller and hand tracking interaction to engage with the virtual environment. User reactions were overall positive but there were clear issues relating to hand tracking. These hand tracking issues probably stemmed from the low contrast between the user's hands and the background produced through a combination of poor lighting (open sided undercover area with bright sunlight outside of it) and dark skin tone. Despite this, users enjoyed moving around the virtual environment, describing what they were seeing and watching others use the VR headset.

The second session in October had a greater number of users and more detailed responses were collected. The session was further augmented by streaming the user's point of view in the VR experience to a smartphone (Figure 7). User feedback from the second session was placed into three broad categories, *Liked*, *Did not like* and *Want* (Table 1).

Figure 7. Andrea Jalandoni holds out mobile phone stream of the user's view, user in the background. Photo by Paul S.C. Taçon 2023.

Liked	Did not like	Want
Campfire	Dizziness/Discomfort	Better accessibility
Moving things around	Hand tracking interaction inconsistency	More natural elements like animals
Watching the livestream	The movement system/limitations	More interactivity with environment
Natural elements		Fantastical elements e.g. paintings coming alive
		Use in different contexts, e.g. schools, museums

Table 1. Categories of user responses.

There was uniform appreciation for the environmental assets, with the campfire drawing particular attention as the only animated feature. This affirmed the changes made based on recommendations from the first session. Interaction with the bark paintings was again popular, with some users manipulating them in unexpected ways such as constructing their own bark structures out of the paintings. Outside the virtual environment, livestreaming the user's perspective to the smartphone proved valuable for other community members and the project team to pierce the isolation brought on by wearing the headset, allowing greater social interaction.

As in the first session, issues were observed with the hand tracking interactions as some users struggled to manipulate the bark paintings, but this seemed to come from inadequate gesture recognition rather than lighting conditions. Some users reported feeling dizziness and discomfort while wearing the headset which is not an unusual consequence of VR use. The expansion of the virtual space to include more bark paintings in session two produced some issues with virtual locomotion as users were unable to access certain paintings due to the physical space not being large enough to facilitate walking to parts of the virtual space.

Despite the issues identified, users were enthusiastic in providing recommendations and desires for future versions of the program. These primarily targeted adding to existing features such as more environmental assets, expanding interactions and making the space livelier with animations. For example, some users suggested being able to trace over or add to the bark paintings, or even make their own. Additionally, users suggested improving accessibility regarding comfort and virtual locomotion. Senior artist G. Maralngurra also suggested other future directions, such as expanding its use to schools and museums, and incorporating more fantastical elements to the virtual environment. It was noted that the uncorrected colours on the bark paintings did not present an issue to the users, rather, the exaggerated colours may have improved the viewing of the paintings.

Further feedback was gathered regarding the personal feelings and observations of some users. Senior artist Merrill Namundja joined in both sessions and made notable comments regarding the connection it created between the past and present.

...they [ancestors] used to live in shelter or cave shelter... and reminds me that, when I saw that it made me really kamak yoh makmen (feel good/feel better), really proud, yes, it's really good, kamak! (good!) - Merrill Namundja

Another user, Conrad Maralngurra, made the tongue-in-cheek comment "Oh, I thought it would be heavier" when picking up the virtual bark painting but in doing so raised the relevant issue of tactile feedback in VR experiences, or lack thereof.

4. Discussion

The primary aim of this activity was to provide the Gunbalanya community with accessible digital versions of this significant bark painting collection because of the difficulty and cost associated with accessing the physical versions 3,000 kilometres away in Melbourne. While this could have been simply resolved by making the photogrammetry models of the bark paintings available via file transfer, this is not necessarily any more accessible, and it makes engagement with the bark paintings disembodied. In using the VR medium, the presence of the bark paintings is made accessible and the individual's experience of them is embodied, even if in digital form. This sense of an embodied experience emerges from the agency provided to users through control of their avatar (in this case locomotion and head movement tracking) and interaction with the virtual environment (Guy et al. 2023:3). Equally, violation of this autonomy or unreciprocated interaction attempts can diminish the user's sense of being in a place. This was seen during the sessions when hand tracking did not adequately translate the user's intention to the bark paintings but was also evident in the attempts of users to manipulate other elements of the virtual environment and the requests that these elements be made interactable.

This desire that an environment or objects within it respond to an individual's expectation harkens back to Walter Benjamin's writings on authenticity, specifically that when something is gazed upon intently, such as in the appreciation of art, the gaze must be returned (Benjamin [1935] in Arendt 1969:188 trans. Zohn). Having the gaze returned in turn validates the existence of both the individual and the object of their gaze. While Benjamin's writings on authenticity rallied against the erosion of authenticity through mass industrial replication, something which digital replication now far surpasses, modern re-interpretations have questioned the role of replication in how we sense the authenticity of an object or place. Latour and Lowe (2011) argued that context is critical to producing a sense of authenticity, whether it be geographical, cultural, or aesthetical and that the objective authenticity of the object itself is not of overarching importance. Within digital archaeology this has been further explored and expanded upon.

For example, Cassidy et al. (2019:172-173-7) and Davis et al. (2017:13) identified in their 3-D reconstructions of First Nation rock art sites, North American and Australian respectively, that users felt the motifs were disconnected from their environmental context without the surrounding landscape being included. In the VR Bark Painting experience this was resolved by constructing a believable landscape and context for the bark paintings and was rewarded by the positive feedback from users. The other element to creating authenticity in replicas that Latour and Lowe (2011) identified was co-creation and community engagement. In digital archaeology, Jeffrey (2018) identified in a case study on the ACCORD project based in Scotland that embedding communities in the development pipeline for digital heritage and acknowledging their contributions had a profound impact on how the community appreciated the authenticity of the digital reconstructions. With this in mind, co-creation with Gunbalanya community members was pursued through the use of the Rapid Application Development method which utilises regular user testing and feedback as new features are added to the program to improve the end result. However, travel constraints limited the depth of this co-creation to less than what was desired.

The effects of this limited co-creation were apparent in the feedback provided in the second session which noted a lack of certain environmental elements which would have contributed to a sense of authenticity and greater cultural familiarity. This included things such as burning off the grass, camp dogs and other animals. Additionally, G. Maralngurra whose art is known for its incorporation of spiritual elements, suggested that the paintings, many of which depict spirit beings, could come alive in the presence of the user. This highlighted a discrepancy in what the archaeologist turned VR developer conceived of as authentic versus an authenticity that was culturally embedded. In hindsight, pursuit of objective, historical authenticity within the VR experience was ignorant of both Indigenous ontology and, more so, that VR offers the ability to become unconstrained by objective reality and allows the pursuit of embodied experiences that reflect different understandings of the world. This may have become apparent earlier in the project if greater engagement and co-creation had been implemented.

Returning to the aim of this project, the VR experience did succeed in providing greater accessibility to the collection for many members of the Gunbalanya community, though issues of discomfort remain a barrier for a small number. There are a variety of possible solutions to this which will require further testing and it is an issue which should remain central to the development of future iterations to ensure everyone has equal opportunity to enjoy the experience. Despite the issues associated with it, it is clear that the VR experience enabled far greater interaction with the bark paintings in the collection than would ever have been practically possible with the physical versions alone. Furthermore, the virtual environment constructed to host them would similarly not be conducive to preserving the physical versions if replicated in real life, but within this virtual environment users could freely explore placing the bark paintings in different ways without fear of damaging them. In doing so, users are presented with a hyperreality, that being, a reality which is an imperfect simulacrum but equally superseding the experience of our lived one.

The ethicality of producing these hyperrealities of the past is contentious, particularly when considering the impetuous which is often placed upon archaeologists to abide by objective ideals, something which is fundamentally disrupted by digitisation (Gillings 2001:28). Equally, its apparent benefits are clear. For example, Merrill Namundja's comments regarding a sense of pride and personal fulfilment from the VR experience can be interpreted as affirmation of cultural identity.

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As McIntosh and Prentice (1999) note, affirmation of cultural identity can be particularly potent when stemming from reconstructions of the past because they play on conceived ideas and nostalgia rather than lived experience. Moreso, within the Australian First Nations context, cultural identity has often been a bulwark against corrosive colonial forces and therefore the affirmation of cultural identity in the face of this might be more effective (Sarra 2011:50-102). Furthermore, these conceived ideas of the past are more malleable than lived experience, meaning that reconstructions of the past are not as readily scrutinised for minor discrepancies which would be more apparent in a contemporary and familiar setting. The benefit of this conceptual flexibility is it allows a virtual hyperreality such as the Bark Painting VR experience to be immersive within the computational design constraints outlined previously. Conversely, this flexibility allowed by the forgiving imaginations of users can unintentionally or deliberately cause inaccurate conceptions of the past to be propagated or affirmed. Some methods have been deployed in Digital Archaeology to mitigate this issue, such as an authenticity colour coding system for virtual environments used by Kastanis (2019:132) or Lanjouw and Waagen (2020) but they are not necessarily conducive to an immersive VR experience.

5. Conclusion

The use of Virtual Reality as a medium for enabling communities to access and immerse themselves within digital heritage data, something which is only increasing in quantity and fidelity, appears quite alluring. As highlighted in this project and others, it requires a considerable deviation from typical archaeological workflows and skillsets to produce these kinds of experiences (Keep 2024:82). But as Spry (2024) noted, archaeologists still flounder when it comes to utilising modern communication technologies to ensure that their research is effectively disseminated and consequently public perception of the field falters. Consequently, we need to consider the efficacy of novel mediums like VR more seriously and regularly in research designs even as questions of authenticity remain unresolved.

This method can and will likely be reused into the future for this work in and around Gunbalanya as it explores related rock art sites, which can often be stylistically identical (Taçon et al. 2023). While these rock art sites pose different challenges for producing virtual experiences, much can be adapted from the findings of this study.

Beyond its potential value as a communication tool, there is considerable utility to be explored in what it offers to the communities which so many Australian archaeologists work closely with. Accessibility is an obvious advantage, but it is the intimacy of the access and its effect on users which differentiates it from other methods. Effects like cultural affirmation identified in this project require further investigation but offer archaeologists another potential way to ensure that their research leaves a positive legacy within Indigenous communities.

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