VIRTUAL RECOLLECTION:
ARTIFACT ENGAGEMENT IN THREE-DIMENSIONAL ENVIRONMENTS

BY

RYAN ACHTEN

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Abstract

Cultural institutions, specifically libraries, museums, and archives, have long been recognised for their collection and preservation of artifacts as a means of conserving cultural memory. With an emergence of digital modes of archiving, an emphasis has been placed on reproducing existing physical artifacts as digital representations and archival of born-digital media. Within the common practice of representing three-dimensional digital artifacts as two-dimensional counterparts, only a facet of the original artifact is represented; omitting valuable spatial and contextual information while precluding opportunities for new forms of artifactual engagement.

By adopting the gaming engine Unity3D, software for interfacing with archive collections was developed to explore how digital three-dimensional spatiality within cultural institution practice may enhance interaction between users and artifacts. Using a combination of configuration, probe, and abstract experimentalist devices, this research explored ways users may engage with digital artifacts in their native spatiality, and the opportunities or limitations these interactions may give rise to. By exploiting diegetic space intrinsic within interfaces, environmental narratives may become powerful tools when communicating and understanding artifactual information. This paper delineates aspects of narrative potential within artifacts and their surrounding environment possible through three-dimensional representation.

Keywords: three-dimensional, artifacts, archives, cultural institutions, museums, libraries
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Introduction

Cultural institutions, specifically libraries, museums, and archives, have long been recognised for their collection and preservation of artifacts as a means of conserving cultural memory. With an emergence of digital modes of archiving, an emphasis has been placed on reproducing existing physical artifacts as digital representations and archival of born-digital media.

By representing three-dimensional digitisations and born-digital media as two-dimensional counterparts, only a facet of the original artifact is represented, discarding valuable visual and spatial information during translation. While this process provides an efficient means of documenting three-dimensional media, it neglects information essential to artifact contextualisation and understanding; information of potential importance to our cultural memory.

This paper looks to provide a precedent for effectively representing three-dimensional digital artifacts within archive space. Software for interfacing with archive collections was developed to explore how digital three-dimensional spatiality within cultural institution practice may enhance interaction between users and artifacts. Specific emphasis was placed upon ways users may engage with digital artifacts in their native spatiality, and the opportunities or limitations these interactions may give rise to.
Preliminary Research (Literature Review)

1.1 DIGITAL ARTIFACTUAL VALUE

Regardless of how close technology may replicate an artifact, even a perfect reproduction is, by sentiment of Benjamin, lacking one essential element; an artifact’s ‘unique existence’ (Benjamin, 1982, p.218). An artifact’s unique existence relies on the corporeal status of the original, where its reproduction omits attributes significant to the artifact’s authority; such as changes and demarcations to the original object’s physical condition (Benjamin, 1982, p.218).

Birth of the ‘digital artifact’ evoked sentiments similar to Benjamin’s critique of the mechanical reproduction processes proliferating during his time. Where the essence of preserving artifacts lies in retaining original meaning of a document, archival of digital artifacts poses difficulties, not only in maintaining original form and functionality but also when establishing authenticity, validity and evidential value (Council on Library and Information Resources, 1999, p.3).

1.1.1 DIGITAL MATERIALITY

Fundamental in evaluating artifactual value is the nature of what qualifies as ‘material’ for archival; commonly attributed to notions of matter and physicality (Leonardi, 2010).

To account for material attributes both digital and physical artifacts provide cultural institutions and their patrons, understanding artifactual materiality should be based upon relationships between the artifact and those who utilise them (Leonardi, 2010). From this vantage, Leonardi suggests three modes in which materiality can be considered (Leonardi, 2010):

1. Matter
   • Qualities related to the matter of an artifact’s physical constitution. Matter is the common understanding of materiality, however, this form only becomes essential when attributes associated with an object’s matter are necessary to achieve the task at hand.

2. Practical instantiation
   • Making ‘material’ abstract ideas. Regardless of digital or physical nature, an artifact which transforms the conceptual into practicality may be considered material.

3. Significance
• Features ‘material’ or significant to the individual. Attributes offered by an artifact vary in value to the respective needs of each user.

1.2 ARTIFACTUAL INTERFACES

By defining materiality on the basis of user interactions, the digital artifact (be it of physical or digital origin) becomes an interface to an original artifact's information; allowing users to access artifactual information without an immediate necessity for the original artifact being present. Instead of viewing digital artifacts as ‘technical media’ by means of their storage, transmission, and processing (Galloway, 2012, p.18), the digital artifact as an interface becomes a mode of mediation, a middle, a compromise, and a certainty (Galloway, 2012, p.18) to accessing original artifactual information. Changing focus from artifact media to their practice and effect looks to help reduce anxiety surrounding presence (Galloway, 2012, p.9), represented previously by sentiment of Benjamin and the CLIR.

This shift does not, however, render original artifacts inessential within the archival paradigm. Original information is necessary for production and substantiation of a replica. It is required when deriving material-specific data, for inscribing digital counterparts, and for standing in testimony of contextual information. The presence of the original, however, once prerequisite to observable authority and outside the bounds of reproducibility (Benjamin, 1982, p.218), is no longer required for viewer engagement.

1.2.1 INTERACTING WITH DIGITAL REPRESENTATIONS

A move from physical into digital realms not only accounts for digital forms of cultural production but also provides a means of renewal for existing cultural heritage (Giaccardi, 2006, p.30).

From an institution perspective, digital platforms enable artifacts previously confined to institution basements to become economically accessed from innumerable gateways; producing a fission where one artifact is divided into the multiple (Galloway, 2012, p.17). Furthermore, by exploiting the intrinsic virtuality of artifacts (Giaccardi, 2006, p.29), new modes of collection engagement may be explored without pressing physical, spatial and economic restrictions.

In the public view, digital archives permit patrons access to artifacts at their own convenience, beyond geographical constraints. Digital platforms may also be implemented to enable participatory contextualisation and recollection (Blome & Wijers, 2010); offering contribution and authorship...
within a frequently enigmatic process.

1.2.2 SPATIALITY IN DIGITAL REPRESENTATIONS

Blurring distinctions between physical and digital artifacts are those produced by means of digitisation. Through the use of capturing technologies, two-dimensional or three-dimensional physical artifacts may be emulated for digital representation. Within the first of Leonardi’s notions of materiality, digitisation processes omit in their reproduction facets of information essential to the original artifact’s physical existence and understanding. However, applying Leonardi’s second and third principles, physical attributes absent in the physical artifact’s digital representation may be of little relevance to members of its audience.

A common representation of physical artifacts within digital platforms involves their inscription using capture methods into two-dimensional derivatives such as image scans, photographs, or videos. While this approach often avoids extensive technology or labour, reliance on two-dimensional representation for certain artifacts has dire limitations.

In the case of three-dimensional artifacts (for instance: sculptures, monuments, buildings), three-dimensional spatiality becomes compressed to fit within the two-dimensional planes of an image or video. During this compression, material information dependent on an artifact’s spatial constitution are omitted; information potentially crucial for appropriately understanding the artifact. Details such as demarcations to an artifact’s surface and the reasons behind their manifestation are each lost to the flat lens of two-dimensionality.

An emerging field of ‘virtual heritage’ looks to appease spatial misrepresentation through the use of scientifically-approved three-dimensional datasets derived from physical objects, buildings, and entire cultural sites. By adopting three-dimensional digitisation methods, virtual heritage enables preservationists to safeguard physical artifacts from temporal degradation and even restore damaged artifacts back to their former glory through digital modeling and scientific advisory processes (Koller, Frischer & Humphreys, 2009, p.8).

1.3 (3D) BORN-DIGITAL MEDIA

Within a local sphere, cultural institutions including the National Library of New Zealand and Museum of New Zealand Te Papa Tongarewa, are establishing measures for conserving artifacts produced in digital environments (or ‘born-digital’ artifacts) which contribute to New Zealand’s
modern cultural identity (Department of Internal Affairs, 2013; Kingston, 2014; National Library of New Zealand, 2011). Thus far, institutional references to virtuality and the born-digital artifact, are typically used with regards to hypertextual media such as websites (Giaccardi, 2006, p.29), whose spatiality can generally be aptly catered for in two dimensions.

However, increasing adoption of three-dimensional digital media within an array of creative and scientific applications suggests a trajectory from two dimensions into three (Manovich, 2002). When understood as a progression in organisation and description of data (Manovich, 2009), simply compressing polygons into pixels is not an appropriate measure for suitably documenting the existence of digital three-dimensional artifacts and their contextual information.

If the fundamental principle of preserving artifacts is retention of meaning through maintaining original form and function (Council on Library and Information Resources, 1999, p.2), it becomes essential to understand how the form of three-dimensional digital media functions within various industries to allow appropriate conservation of artifact meaning and purpose. Ensuring concise and achievable analysis, this research focuses types of born-digital three-dimensional media currently utilised within creative discourses: computer-assisted design, animation, and game design.

1.3.1 MEDIA DEPENDENCY

The role of three-dimensional artifacts within the aforementioned discourses is typically dependent on various material attributes, necessary for fulfilling their industrial function. A computer-assisted design (CAD) artifact relies on attributes material for interpretability by manufacturing machines. Similarly, artifacts produced for animation require material attributes for the artifact’s movement; such as ‘rigs’ used in skeletal animation. Three-dimensional assets used in gaming or virtual reality outputs pose a unique and difficult set of emulation issues for effective archival. These assets depend on an assortment of external objects making up the overall environment and visual experience; encompassing attributes such as additional models, code, and specific hardware requirements. Furthermore, while the environment as a whole is generally considered the artifact in question, constituents comprising the output could each be assessed in terms of their archival merit.

To preserve each material attribute described above as functional during archive representation would require a vast assortment of functionality (often prone to becoming outdated or obsolete). However, each set of attributes described above can only be deemed necessary within Leonardi’s
**significance** materiality if they constitute a functional aspect of user activity within the archive. Where the fundamental value of artifacts is how they are perceived and subsequently used (Leonardi, 2010), the primary objective of an archive might be to facilitate access to artifacts and their contextual information; with attributes outside of those necessary to communicate an artifact’s essence lying beyond the immediate responsibility of institution archives.

### 1.4 VIRTUAL ARCHIVES

Despite cultural institution use since the mid-1980’s (Koller, Frischer & Humphreys, 2009, p.8), there remains limited adoption of digital three-dimensional media as an archival medium within a local sphere, nor centralised virtual heritage archives from an international perspective. As noted in research of Koller et al, an absence of such repositories has already lead to serious consequences; primarily a lack of plans for preserving digital heritage models (Koller, Frischer & Humphreys, 2009, p.9), excluding artifacts potentially important to cultural memory and identity. Their research continues by suggesting the development of scientifically-authenticated repositories for virtual heritage, following precedents such as scholarly and photographic archives to enable collection, review, publication and preservation of virtual heritage artifacts (Koller, Frischer & Humphreys, 2009, p.9).

Recommendations submitted by Koller and his peers provide steps necessary for appropriately documenting digitised media within institution practice, however, they fail to recognise the cultural value of born-digital artifacts produced by creative industries. Additionally, by emphasising strict scientific authentication, platforms restrict and even discourage community contribution of artifacts and anecdotal evidence (Giaccardi, 2006, p.36); valuable as collection items or contextual information within archives. Furthermore, imitating scholarly publication and photographic archive precedents continues to rest upon an existing two-dimensional archive model; ignoring modes of collection engagement possible through three-dimensional spatiality. Introduction of new kinds of media into archive practice creates an opportunity for inventing new interfaces to collections as well as new systems for artifact description and categorisation (Manovich, 2009); both of which warrant exploration.

### 1.4.1 VIRTUAL ARCHIVE CHARACTERISTICS

A more suitable precedent for how collection interfaces might evolve by introducing three-dimensional spatiality can be found in the modern computer game. Emphasising forms of *play*, game mechanisms aid in resolving complex relationships through mutual experimentation and
engagement (Galloway, 2012, p.28); attributes of obvious value to public interaction with cultural institutions.

Unfortunately, institution exploration with computer game systems has been limited to trials undertaken for selected audiences, such as teachers and children; restricting applications to emphasising traditional pedagogy (Urban, Marty & Twidale, 2007). Correlating to processes for scientific-authentication recommended by Koller and his colleagues, the focus of museum exploration within this field ensured accuracy in digital representation (Urban, Marty & Twidale, 2007), as opposed to investigating how technologies may provoke creative interaction between the physical, cultural and virtual (Giaccardi, 2006, p.30).

Adopting computer games as a precedent for navigating three-dimensional archives allows designers and developers to leverage interaction principles already recognised and adapted to by audience members. Utilising standardised input configurations, such as ‘W,A,S,D’ keys reserved for character movement, developers look to reduce the learning curve of users adopting three-dimensional archives. Situating cultural archives within this form of interactivity may also serve to expand public interest in archival practice outside of existing practitioners; potentially exposing cultural institution collections to entirely new audiences.

Precedent for game-derivative archive approaches can be found in research by Urban et al, who investigated a proliferation of museums and galleries emerging within the virtual world, Second Life. Collections in Second Life virtual exhibitions contained a mixture of both born-digital artifacts (such as new media artworks), digitised physical artifacts (such as renowned art and monuments), and even reproductions of entire cultural sites (Urban, Marty & Twidale, 2007). The governing curatorial factor of the virtual collections, was not authenticity in reproduction, instead focusing on extracting key features while emphasising how artifacts and supporting contextual information were displayed and engaged with (Urban, Marty & Twidale, 2007).

As the virtual collection is not limited by constraints of physicality, curators can provide opportunities for engaging with artifact items otherwise restricted by laws of physics or economic concerns of the real world. Artifacts may be displayed simply on the walls and floors of gallery space; adopting a real-life metaphor, or encountered mid-air; requiring visitors to fly to the location. Accordingly, scale of virtual collections vary depending on intended purpose or experience; one
exhibition may encompass only a room whilst another an entire island. Though analysis of virtual collections in *Second Life*, Urban et al identified characteristics which provide valuable insight as to service needs of a potential audience, as well as benefits from approaching digital three-dimensional artifacts in their native spatiality.

### 1.4.2 ENVIRONMENTAL NARRATIVES

Embracing computer games as a precedent for engaging with digital three-dimensional media becomes useful when considering how diegetic space in archive interfaces might play a prominent role in communicating and producing cultural narratives through environmental storytelling. As environmental narratives are perpetuated by their infusion into physical or virtual space (Jenkins, 2007, p.56), archive adoption of environmental storytelling has previously been restricted by two-dimensional digital collections. Within three-dimensional archive interfaces, narrative experiences may be constructed in four forms: those which are evoked, enacted, embedded and emergent (Jenkins, 2007, p.57) inside archive environments.

Of particular relevance to the function of archives are *evocative spaces* which draw upon memories of visitors to remediate existing stories (Jenkins, 2007, p.57). Here the digital artifact provides concrete shape to historical events or imaginings of a fictitious world, effective when communicating complex or expansive cultural memories (Jenkins, 2007, p.57); such as a digitised wartime decoration evoking details from a conflict, or iconic gaming assets representing the wider system from which they originate.

Within game design, *enacted narratives* pose difficulties as they tend towards being too episodic or constricting to be communicated effectively (Jenkins, 2007, p.58). Outside of gameplay constraints, however, constructing narratives through organisation of artifacts and user objectives may provide interesting collection structures by privileging spatial exploration. Using this framework, curators arrange digitised artifacts to represent the geographical positioning of an original site or the chronological order in which they originated; enabling visitors to virtually walk through digital collections in a manner comparable to a physical exhibition.

*Embedded narratives* may take place in two forms: the first emerges as users unlock ‘secrets’ from within an environment, whilst a second form awaits discovery though impregnation within mise-en-scène; transforming the environment into an information repository or ‘memory palace’ (Jenkins, 2007, p.58). The former suggests a mode of interactivity where users traverse curated space and
access information by engaging with their virtual surroundings. The later form is reminiscent of an archive or curated collection as a whole; a ‘memory palace’ whose information is lying in wait of its discovery by visitors.

By allowing procedural authorship within environment design, users are able to communicate their own stories; producing *emergent narratives* outside of those designated by the environment’s creators (Jenkins, 2007, p.59). Enabling open contribution within digital archive constructs creates a platform where narratives beyond those collected by governing institutions are able to emerge and be preserved as aspects of cultural memory. Such functionality can take place through enabling the public to upload personal artifacts important to their heritage or identity, or by allowing users to contribute knowledge and anecdotes about existing artifacts; furthering an institution’s contextual information on collection items.
Hypothesis

Informed by the literature analysed above, the hypothesis of this research anticipates users of cultural archives will benefit from introducing three-dimensional media into digital collections through the new modes of inspection, browsing, and curation this spatiality allows for.

Forms of interaction facilitated by three-dimensional archive environments are expected to further users’ ability to communicate and derive artifact information, query effectively for digital artifacts residing within an archive, and enhance methods for curating collections of digital artifacts.

[See Appendix A for Operational Definitions adopted in this paper]
Methodology

Output from this research looks to provide a case study for effectively representing three-dimensional digital artifacts within archive space. To qualify as such, software for interfacing with archive collections was developed to produce insight into how digital three-dimensional media within cultural institution practice may enhance interaction between users and artifacts. Specific emphasis during interface development was placed upon ways users may engage with digital artifacts in their native spatiality, and opportunities or limitations these interactions may give rise to.

As the nature of this study entails a combination of new ideas surrounding technologies, analysis of cultural practices, as well as software development and testing, no single methodology researched suitably accounted for all aspects of the project. Instead, a combination of inventive methods (Lury & Wakeford, 2012) were employed as a method assemblage during development and reflective stages by integrating configuration, probe, and abstract experimental devices to produce and analyse this research.

3.1 ARCHIVE INTERFACE DEVELOPMENT METHODS

To evaluate how the creation of an interface fulfilled the research premise previously stated, development and analysis of the software rest upon two research methodologies; probe and configuration devices.

3.1.1 PROBE METHOD

Due to a lack of precedents for archive interfaces facilitating engagement in three-dimensional space, it is useful to perceive the archive interface in this project as a probe device. Its development looks to offer new perspectives of cultural institution practice, framing possibilities and conversation about potential roles for three-dimensional media as opposed to offering singular truths (Boehner, Gaver & Boucher, 2012, p.185).

It could be argued this research deviates from the function of a probe device, where only one probe artifact (the archive interface) was developed during this research; contrary to a probe method implying production of multiple probe artifacts to interrogate different aspects of a situation (Boehner, Gaver & Boucher, 2012, p.196). However, as later discussed in reference to the
configuration methodology, when each element comprising a system is understood as ‘artifact’ in their own right, this archive interface therefore be understood as a probe kit or packet; where each interface element contributes towards a multidimensional understanding of how three-dimensional media may benefit cultural institutional practice.

Elements constituting the various probes of this methodology can be loosely abstracted from three distinct phases within the archive interface:

1. importing digital artifacts into an archive
2. browsing digital artifacts within an archive
3. curating collections of artifacts from an archive

3.1.2 CONFIGURATION METHOD

To effectively evaluate each phase and how they contribute to the interface as a whole, the configuration method has been employed to solidify each element’s bounds of analysis whilst drawing attention to the way interfaces may ‘materialise cultural imaginaries’ (Suchman, 2012, p.48).

Essential in achieving this is the configuration method for reanimating the figure; where employing practices of differentiation and association helps identify figurations within the system and delineate the functionality each element incorporates or excludes (Suchman, 2012, p.50).

An initial boundary worth noting is where this case study does not intend to produce a fully matured archive; a term implying database and metadata constructs beyond the bounds of this research. Instead, an archive interface has been developed with an expectation it will be implemented alongside databases housing three-dimensional digital media.

Chapters following this paper’s Methodology [see 4 - Results] will reanimate the interface by identifying boundaries present within the resulting software, and discussing functionality incorporated (or omitted) for materialising artifactual engagement.

In addition to identifying figurations, the configuration method promotes consideration of how these figurations may act as a mode of production; allowing for circulation of artifacts and their subsequent recontextualisation, multiplicity and potential transformation (Suchman, 2012, p.50).

Contrary to recommendations from Koller et al for scientific authentication of heritage artifacts, this interface emphasises the open contribution of artifacts; demonstrating how archive interfaces may further participatory contextualisation and recollection by digital interfaces (Blome & Wijers, 2010).

Allowing for an open contribution of artifacts further highlights a need to account for multiple logics; differentiating rationale when adopting systems such as an archive interface (Suchman,
These rationales were modelled early in development through various user experience exercises [discussed further in 3.2.1 - Test Participants]; bringing attention to different perceptions of artifactual value held by archive interface users. By considering multiple logics, the interface looks to avoid homogenising shared imaginaries into one translation of artifactual value (Suchman, 2012, p.51-52).

Figuration of the browse and collection scenes differentiate from the importing scene as they (more) explicitly demonstrate what Galloway characterises as a divide between the edge and centre of an interface (Galloway, 2012, p.42). The interface edge is represented by the graphic user interface; reserved for non-diegetic information relating to interface functionality and contextual information. A differentiating attribute of the latter scenes takes place within their centre interface, where modes of interaction aim to exploit the diegetic potential this space allows for (Galloway, 2012, p.42). As a probe device, these scenes serve to experiment with how three-dimensional spatiality may facilitate playful forms of archive engagement.

3.2 INTERFACE USABILITY TESTING METHOD

To understand how three-dimensional archive interfaces might be adopted by users, it was essential the software was trialled through usability testing. In order to derive results applicable to real-world conditions, usability testing drew upon a third inventive method; abstract experimentation. By employing an abstract experimentalist device, a controlled artificial situation could be constructed at a functional equivalence to cultural institution implementation; allowing for the conduct of participants during user testing to be read as ‘authentic’ without recognising the staged conditions of user testing (Brown, 2012, p.67).

In order to construct conditions equivalent to real-world implementation, a series of user testing sessions [discussed further in 4.6 - Usability Testing] were devised within a structure reflecting natural usage of the interface software. These trails sought to gauge first impressions, uncover participant product goals and pain-points still unaccounted for by the software, and acquire feedback on user experience whilst utilising the interface.

3.2.1 TEST PARTICIPANTS

The interface of this research was developed with needs of several user groups in mind, each with their own rationale for accessing archives and engaging with artifactual media; constituting multiple logics present within system design. User groups looked to move beyond binary identities
of 'designer/developer' versus 'user', into categories for describing persons based upon hypothetical locations, moments, histories and investments situating these users (Suchman, 2012, p.57). As a result, a series of assumptive personas were constructed from demographics identified through literature and cultural institution reports to include these attributes [see Appendix B for full persona outlines]. The primary demographics represented by these personas can be broadly understood in the following four subsets:

**Archiver**
- Person whose occupation is associated with the databases, archives or digital interfaces of cultural institutions (such as those of libraries or museums).

**Researcher**
- High school student, tertiary student or academic whose studies leverage archives as sources of information.

**Creative**
- Adopts three-dimensional production as part of their creative discourse. Creative discourses encompass a variety of fields including designers, animators, game developers, architects, as well as artists.

**General User**
- Individuals who do not fall into the previous subsets are considered general users of the interface and are therefore not anticipated to have prior experience with three-dimensional production processes or digital archives.

To trial the interface effectively against its intended demographic, participants from each subset were sought to partake in user testing. A participant's ability to qualify as such was evaluated using a participant screener, seeking information as to potential participants' age, occupation, and experience in relation to cultural institutions, digital archives, and three-dimensional production software [see Appendix C for User Testing Participant Screener].

Incorporating an abstract experimentalist device into the user testing process further recognises results from testing environments as being concentrated, albeit abstract, in form (Brown, 2012, p.71). Results and the conditions they were derived from are not intended to exactly replicate normative experience but provide an equivalence to conditions present in real-life (Brown, 2012, p.71). For such an equivalence to be constructed, it becomes essential that human drama within the testing environment is not reduced to turning on a pivotal moment in the testing process (Brown, 2012,
Accordingly, questions and tasks requested of participants were intentionally open to avoid coercing favourable results.
Results

Through the methodologies described above, a number of research outcomes were produced during this research. By means of configuration to delineate system functionality, and probe devices to trial new approaches during software development; this case study provides a number of considerations for importing, browsing and curation of digital three-dimensional artifactual media within archive interfaces. Adoption of an abstract experimentalist approach within software testing further allowed propositions to be tested at real-world equivalence; returning valuable feedback on how such systems may be adopted by professionals and patrons of cultural institutions. The results detailed below look to contribute towards an understanding of how digital three-dimensional artifacts might be best represented and engaged with by their audience using interfaces to institutional archives.

4.1 SOFTWARE FRAMEWORK

A notable research outcome resulting from this study is how the software framework dictates the degree and types of interactivity an archive interface can cater for. Precedents for archive interfaces can be found in existing virtual heritage archives, some of which are discussed at length in the case study by Koller et al. Popular amongst these precedents are viewing systems which prioritise display of high-resolution three-dimensional models and protection from theft of restricted media (Koller, Frischer & Humphreys, 2009, p.11).

One notable viewing system, ScanView, adopts an approach where users alter their perspective of a three-dimensional artifact using a simplified version of the model, before a full resolution two-dimensional image of the artifact is rendered (Stanford Computer Graphics Laboratory, 2010). While this helps mitigate many piracy concerns surrounding institutional three-dimensional media, only providing access to two-dimensional renders of artifacts ignores opportunities from three-dimensional digital artifacts being engaged within their native spatiality.

4.1.1 INTERACTION VS RESOLUTION

To promote an environment where the full potential of user engagement with artifacts could be explored, established three-dimensional viewing systems, such as ScanView, were eschewed within the framework of this research. Instead, a gaming engine popular amongst independent videogame developers, Unity3D, was selected as the archive interface software framework for it being an
environment which favours user interactivity above all.

Adopting a gaming engine over high-fidelity viewing environments evokes a previously discussed debate [see 1.4.1 - Virtual Museum Characteristics] on understanding digital artifacts and how they should be catered for within archives. From a preservationist perspective (demonstrated by Koller et al) a system for inspecting three-dimensional digital artifacts in the utmost resolution (such as ScanView) may appear preferable. However, from a curatorial mentality favouring creative interactions between user and artifact (exemplified by Giaccardi), gaming engines (such as Unity3D) differentiate by the intrinsic manner they manage digital three-dimensional media. Partiality to the creative over singular truth (such as 'factual' representation) can be further read as indicative of the interface functioning as a probe device, which too favours possibilities from playfulness over utilitarian values (Boehner, Gaver & Boucher, 2012, p.194).

Ability for interface users to interact with three-dimensional digital media, as opposed to two-dimensional renders, does not reside solely within the bounds of Unity3D's framework. Other programming languages and development environments could have been employed (i.e. Java, C#, C++) to develop similarly flexible systems, which depending on requirements for institution implementation, may be the preferable approach. However, gaming engines have an added incentive of providing core functionality (discussed in the section below) optimised for representing and interacting with three-dimensional digital media. As a probe device emphasising playful interactions and trialling new forms of artifact engagement, these sets of functionality became indispensable for interface development within the research timeframe and economic constraints.

Cross-platform in nature, Unity3D allows builds to be integrated with archives residing on a variety of operating systems. This platform flexibility further enables collection artifacts to be explored using consoles and hardware whose archive experimentation has thus far been limited; providing scope for probes and figurations, such as those exploring virtual reality (VR) and augmented reality (AR), to be pursued subsequent from this research.

4.1.2 REAL-WORLD SIMULATION

Typical of game engines, the Unity3D framework includes a physics engine, allowing for forms of artifact engagement prevented by two-dimensional rendering systems. Physics engines help introduce a real-world metaphor into archive engagement by providing computational systems for collision detection. Collision detection calculates intersections between objects, providing scope for
complex artifact interactions to occur. In an example where interface users navigate archival space, collision detection allows for artifacts to be picked up, knocked over, or in the case of artifacts retaining kinematics; even operated in a manner resembling its real-world function.

Many of these operations are processing intensive or entail dependency issues previously discussed [see 1.3.1 - Media Dependency], and therefore exceed the bounds of this research. However, when considering software frameworks for archive interface development, these again present avenues for investigating how game engines may sculpt public engagement with digital artifacts of cultural institutions.

4.2 ARCHIVE ARTIFACTS

Unless specifically stated in reference to research methodologies discussed previously, the term ‘artifact’ is used to refer to a digital entity of artifactual value to professionals of cultural institutions and their patrons. To provide an achievable scope for this case study, this research has investigated what has been delineated as two figurations of digital three-dimensional media, virtual heritage, and born-digital artifacts; archival of which is believed to be of particular value to cultural institutions.

4.2.1 VIRTUAL HERITAGE ARTIFACTS

Adopted from the field of ‘virtual heritage’ discussed by Koller et al, virtual heritage artifacts refer to three-dimensional models produced for documentation and cataloguing of data often studied by archaeologists and historians (Koller, Frischer & Humphreys, 2009, p.8). Datasets typically lie within the bounds of digitised physical artifacts; ranging from smaller objects (i.e. pottery), to larger items (i.e. monuments and statues), to entire buildings or cultural sites (Koller, Frischer & Humphreys, 2009, p.8).

Procedures for digitising valuable artifacts typically entail high-resolution capture methods, where models resulting from processes such as photogrammetric scanning are comprised of meshes with exceptionally high polygon counts. Models of high polygon counts require extensive computational resources to effectively process and display them. The same computing resources may be allocated elsewhere for user experience whilst engaging with digital artifacts; again calling into question an aforementioned debate between archival resolution versus creative interactions [see 1.4.1 Virtual Museum Characteristics]. This research seeks to emphasise potential creative interactions between the user and digital three-dimensional artifacts as opposed to retention of resolution.
4.2.2 BORN-DIGITAL ARTIFACTS

Three-dimensional media produced within the digital domain without a physical origin, are referred to throughout this research as *born-digital media*. Three-dimensional models produced for outputs including animation, graphic design, additive manufacturing (AM) and gaming assets were identified as being representative of creative industries whose cultural significance is valuable within the bounds of this research.

Unlike those generated from digitisation processes, born-digital models are generally produced from three-dimensional modeling or computer-assisted design (CAD) software packages; resulting in models often of a lower polygon count. By constituting a lower polygon count, these artifacts are effectively more optimised for archive interfaces due to requiring less computational resources for appropriate display and engagement.

While the mesh of born-digital artifacts may be easier to represent within interfaces, mesh data is often only a fragment of the information necessary to depict an entire artifact. As discussed previously [see 1.3.1 - Media Dependency], born-digital artifacts typically belong within a wider ecosystem, where dependencies are required for full representation of the creative output. Instead of attempting to cater for the entire functionality of each artifact (or the *relational whole* in Galloway terms (Galloway, 2012, p.62)), a more feasible approach is to focus on *constituent parts* (Galloway, 2012, p.62) comprising complex born-digital artifacts. Dividing complex artifacts into their constituent mesh elements and omitting technical attributes such as kinematics during emulation helped ensure manageable interface development within the bounds of this case study.

4.3 IMPORTING ARTIFACTS

One of the primary areas of research outputs from this case study are considerations for how three-dimensional digital artifacts are imported into an archive. Using the *import* scene, users are able to select three-dimensional models from their local system to be added into the archive. Once these have been parsed, users may assign additional information such as textures, metadata, and contextual media to aid understanding of their artifact.
The *import* scene [*Figure 1*] doubles as a platform for inspecting three-dimensional artifacts during user research or leisurely activities. The navigation system to achieve this adopts an interaction model informed by popular three-dimensional production software. Users may rotate and move the artifact relative to camera along each of the world axes (x, y and z). Real-world metaphors for navigating and engaging with three-dimensional artifacts were reserved for later scenes where inspecting objects in close proximity is not high in priority.

### 4.3.1 Artifact File Formats

As previously discussed [see 4.2.2 - Born-Digital Artifacts], three-dimensional data may be produced from software packages in a variety of file formats. Many of these formats are proprietary or rely on attributes material to their respective production software. To account for attributes and functionality specific to each file format would require an importing system of a broad spectrum well exceeding the bounds of this project. Instead of dedicating time and resources towards compatibility with the multitude of three-dimensional graphical formats available in the modern market, development focused on standardising one file format for archive use.

The interface looked to cater for a file format which is compatible with as many three-dimensional production software as possible while remaining within the ‘open’ domain. With this intent, the file format Wavefront OBJ (.obj) was established as the type of three-dimensional model supported by the project. An OBJ file simply provides vertex, face and UV mapping coordinates of the model’s mesh, with additional assets, such as lighting and camera information, added inside of the interface.
The simplicity of OBJ data also makes it a format efficiently parsed at runtime.

OBJ is a three-dimensional graphics format supported by a vast range of software, accounting for multiple logics in three-dimensional media production; including fields of modeling and animation (i.e. Maya, 3ds Max, Cinema 4D), computer-assisted design (i.e. Rhino3D, ArchiCAD, SketchUp etc), and processes used in virtual heritage (such as photogrammetry software PhotoScan and VisualSFM). By residing in the public domain, custom parsers and purpose-driven extensions to OBJ data can be developed for archive importing and exporting purposes, making it an exceptionally suitable candidate for cultural institution archive implementation.

4.3.2 RUNTIME PARSING

Unity3D’s functionality when handling three-dimensional media is often by creation of ‘prefabs’; object instances consisting of components such as meshes, textures and other attributes necessary for representing three-dimensional media. Unfortunately, production of prefabs relies on Unity3D’s editor environment, unavailable to software builds exported from Unity3D; complicating the importing process as well as attribution of associated media and metadata. Because three-dimensional media cannot be stored in the form of prefabs, models need to be parsed each time they are accessed from the archive. For this reason, the method of parsing three-dimensional media by the archive interface is integral to its performance and usability.

Remaining within the ‘open’ intentions of this research, initial trials parsing three-dimensional models relied on built-in parsers within Unity3D. These parsers proved to be much too slow for expected performance of the interface; incurring average parse times of 27.96 seconds for three-dimensional models of an average file size of only 684.1 KB. Not only is an expected file size of 684.1 KB unacceptable, but waiting twenty-seven seconds for each model to load would produce a frustrating user experience in numerous aspects of interface functionality.

To mitigate these issues, an external dynamic-link library (DLL, .dll) plugin was introduced. Developing a comparable DLL from scratch was beyond the bounds of this research, and therefore it became unavoidable that the ‘open’ intentions of this project were compromised. A breach of being ‘open’ in nature can be justified by benefits the proprietary DLL (‘ObjReader’ developed by StarScene Software) provides interface performance [Figure 2, 3 & 4]. When contrasted against the previous load size of 684.1 KB facilitated by the built-in OBJ parser, the DLL allows for an average load size of 3.38 MB, enabling three-dimensional models of nearly five times the size of
those prior to be imported using the interface. Furthermore, these three-dimensional models are imported almost instantaneously, with meshes parsed in under a second.

![File sizes of artifacts parsed by interface](Produced by author, 2016)

**Figure 2.** File sizes of artifacts parsed by interface (Produced by author, 2016)

### 4.3.3 Artifact Compression

An additional boundary presented when adopting Unity3D’s framework as an archive interface, is a 65,535 vertice limit for importing three-dimensional models at runtime. This is a boundary which cannot be mitigated through third-party resources, such as ObjReader, due to Unity3D featuring a 16-bit index buffer for parsing mesh data (Bunny83, 2012).

Resolution of mesh contained in OBJ files can largely be determined by polygon count. Polygons necessitate vertices for their construction; hence, a lower vertice count restricts the resolution of three-dimensional models which the interface can cater for. Such boundaries become particularly of issue when handling virtual heritage artifacts, which, as mentioned previously [see 4.2.1 - Virtual Heritage Artifacts], typically contain high polygon counts likely to surpass Unity3D vertice limits.

One approach for allowing these artifacts to be imported is by subjecting high polygon models to compression processes, such as quadratic edge decimation. By reducing a model’s vertice count, compression processes tend to alter mesh appearance; occasionally producing signs of compression such as holes and reduced topological smoothness. While signs of compression can be restored using production software, the resulting compressed three-dimensional artifacts will be of lower resolution (by means of polygon count) when viewed in the interface than that of the original artifact.
The degree of compression incurred during this process can be attributed to two predominant factors: polygonal size of the original mesh and the parsing method adopted by the interface (Figure 3). Virtual heritage models produced by means of photogrammetry for this study originally contained meshes with an average of 579,047 polygons. To be included in the archive interface, these models were compressed to 45,029 polygons, with an average of 12.79% of the original mesh preserved during interface representation. At a glance, representing only 12.79% of an original artifact’s mesh using the DLL may appear minimal. However, compared to 1.17% previously conserved using Unity3D’s built-in parser (Figure 4), this is a significant improvement, hindered only by Unity3D’s vertice limit.

Resolution catered for by the interface is reflective of adopting Unity3D as the software framework over established high resolution viewing systems. A necessity for compressing artifacts reiterates a popular concern for digital artifacts not containing (or retaining in the case of digitised media) authenticity, validity and evidential value demanded by an institutional perception of artifactual
However, allowing large polygonal mesh sizes to be imported into archive interfaces requires a higher degree of computational resources to process them. Not only would such implementation create barriers in terms of hardware users may run the interface on, but also restrict the interactivity an interface is able to cater for. Instead of dedicating system resources to rendering high-resolution models, Unity3D's vertex count ensures resources are committed to interface performance and user experience while engaging with digital artifacts. In this sense, adopting gaming engines, such as Unity3D, for the purpose of three-dimensional archive interfaces can be understood as an approach which favours creative interactions between user and artifact, as opposed to the exactitude of artifact representation.

Facilitating creative interactions over artifact resolution also highlights an issue considered by Suchman's configuration method, whereby accounting for multiple logics in system rational may lead to incommensurate directions for system design (Suchman, 2012, p.52). Where an emphasis on interaction is anticipated to be attractive to general users and creatives adopting the archive interface, cultural institution practitioners valuing artifactual authenticity may disapprove.

4.3.4 ARTIFACT CONTEXTUAL MEDIA

Recognising that supporting information is often necessary when representing artifacts, an important aspect to the importing phase of development became functionality for assigning contextual media to artifacts added to the archive. Similar to previous discussions surrounding supported file formats, to keep development manageable types of contextual media included within the interface bounds were restricted to three general media types: two-dimensional images, videos, and audio files.

Importing images at runtime is functionality Unity3D builds readily support; allowing for the common JPEG (.jpg) format to be imported. However, common video (i.e. .mp4) and audio (i.e. .mp3) formats are subject to stringent copyright clauses surrounding use of their codecs. To avoid this, Unity3D supports the open container Ogg (.ogg) for audio and video streaming during runtime. While Ogg is not as commonly adopted by cultural institutions or the general public, it is able to contain high-resolution media, and its open nature ensures an abundance of conversion tools freely available for translating other formats.
4.3.5 Artifact Metadata

From its inception, it was anticipated that the interface of this research could be readily assimilated into existing two-dimensional archival systems. Accordingly, metadata standards adopted by local cultural institutions of New Zealand were researched during the project’s development. The International Committee for Documentation (ICOM)’s CIDOC Conceptual Reference Model (CRM) adopted by local institutions such as Museum of New Zealand Te Papa Tongarewa (Te Papa) was investigated for its emphasis on describing implicit and explicit relationships between archive artifacts.

Unfortunately, implementation difficulties arose when integrating CRM’s Resource Description Framework Schema (RDFS) into Unity3D. Implementing CRM within archive interfaces could be incredibly exciting as the relationships and concepts it describes may be depicted in three-dimensions. However its implementation exceeded the bounds of this research due to the time and resources this would necessitate. Instead, a custom schema was developed for housing artifact metadata, used to drive user interactivity and public-facing information. The schema was structured using Extensible Markup Language (XML) for its interoperability by Unity3D, as well as potential mapping to, or communication with, institution archive ontologies such as CRM.

The metadata structure produced in this research does not intend to provide a complete approach for describing digital artifacts but demonstrate various metadata dependencies which archive interfaces, such as the one of this project, will require from standards such as CRM. Further research is required into how an implementation of reference models such as CRM, may further benefit user engagement with three-dimensional digital artifacts and the archive interface figurations this may give rise to.

4.4 Browsing Artifacts

A core aspect of research driven by interface development arose from factors presented during the browse scene design [Figure 5]. The browse scene allows users to search for artifacts in the archive relevant to their area of interest by querying using keywords, or browsing groups of artifacts using predefined categories. Artifacts relevant to user queries are then positioned in three-dimensional space, resembling shelving or exhibition systems established in real-world cultural institution practices.
4.4.1 THREE-DIMENSIONAL BROWSING

Archive browsing is commonly encountered in two-dimensional forms; be it photographic records (media presented as tiled thumbnails), or academic journal collections (displaying content as lists of hyperlinks). Such approaches leverage the two-dimensional spatiality of their content; to apply the same system to three-dimensional archive media would ignore exploratory opportunities a third dimension may allow for. Browsing functionality of this interface exploits the three-dimensional nature of digitised or born-digital artifacts by arranging query results in three-dimensional space. The resulting experience intends to draw upon a real-world metaphor for browsing physical museum or library collections.

Horizontally, objects are grouped alphabetically by a user-defined sorting field (such as the original location of digitised artifacts or production software of designed artifacts), resembling categorical allocation of books in library shelves or groupings of artifacts in museum exhibits.

Within these groupings, artifacts are arranged alphabetically by object name along the depth of the viewing plane.

Upon approaching an artifact, users are presented with displays depicting artifact contextual information previously assigned during the import scene. Using the computer graphics approach, ray casting, artifact detection allows the browse scene to act as an intraface between an artifact’s aesthetic form and the wider cultural context from which it was originally situated [Galloway, 2012, p.53].
Users may then edit the current artifact’s information (returning back to the *import* scene) or add the artifact to one or more collections [discussed further in 4.5 - Curating Artifacts].

### 4.4.2 BROWSE NAVIGATION

This method for displaying artifacts in the *browse* scene requires a different approach to navigation from the one developed for the *import* scene. To navigate artifacts returned from a three-dimensional search query, a user needs the ability to move and adjust their perspective in three-dimensions to view query results. To achieve this, an interaction model inspired by first-person shooter (FPS) player controllers was adopted for *browse* navigation. FPS player controllers utilise the computer gaming standard WASD key commands for moving in three-dimensional space (W = forward; A = left; S = backward; D = right) while mouse position dictates user camera perspective.

Artifacts returned from browse or search queries vary in scale due to different metric systems employed by three-dimensional production software. To account for this, another gaming mechanism was employed within the browsing scene; an ability for users to adjust their height position by ‘flying’. Due to the scale discrepancy, traversing browse returns ‘by foot’ with a number of objects present can be time consuming; by comparison flying absolves this issue. Furthermore, while the first-person perspective is optimal for viewing a few artifacts at close proximity, it becomes difficult to evaluate the return as a whole from a grounded position.

Adopting three-dimensions for browsing poses a new problem for archive interfaces; how should users move between controller input and two-dimensional GUI input. Having both inputs active simultaneously would result in users typing characters into an input field and their controller’s position inadvertently being affected. One solution is to toggle between a navigation mode (mouse and keyboard are dedicated to controller movement and perspective) and browse mode (mouse and keys used to activate various GUI features).

### 4.4.3 RETURN LIMITATIONS

An issue with browsing in three-dimensions occurs when queries return a large number of relevant artifacts, incurring runtime issues such as screen tearing and disrupting user experience. However, when the number of artifacts returned from queries is reduced excessively to avoid these issues, browsing in small returns will result in a frustrating (albeit glitch-free) user experience.

To minimise these effects, a return limit slider was included in the browser design to allow users to
calibrate the interface to their machine specifications and user experience requirements, accounting for multiple user logics and environments.

4.5 CURATING ARTIFACTS

The final research output derived from interface development revolves around how collections of three-dimensional artifacts might be created. The collection scene [Figure 6] provided ability for users to curate collections of digital artifacts for research or personal purposes. Collections may be produced to reconstruct an original site where artifacts were sourced, demonstrate an overarching research objective, or simply to represent the interests of its owner. A defining characteristic of the collection scene is customisability, where users may control their collection’s appearance to communicate contextual relationships between digital artifacts.

Figure 6. Interface ‘collection’ scene (Produced by author, 2016)

4.5.1 MODIFYING ARTIFACT COLLECTIONS

Navigation of a collection closely resembles the approach designed for browsing artifacts; users are able to move around collections of digital artifacts using the WASD configuration while adjusting perspective using their mouse. The collection scene differentiates by having additional input controls for manipulating position, rotation and scale of the object they have selected.

Ability to define positioning of collection artifacts lends itself to the principle of describing contextual information through spatial relationships. Customisability through positioning artifacts is extended by rotation and scaling functionality; allowing users to alter the appearance of archive
artifacts in their collections without affecting artifact appearance in other interface scenes.

4.5.2 COLLECTION NARRATIVES

Modifying artifact collection appearance becomes pertinent to archives when facilitating environmental narratives of both verifiable and anecdotal nature [previously discussed in 1.4.2 - Environmental Narratives], enhancing the interface’s potential as diegetic space. Ability to modify collection artifacts also presupposes presence of multiple logics adopting the interface; where differentiating rationales for producing artifact collections are not restricted by one homogenous view of what figuration an artifact collection should take or be intended for.

Through modifying artifacts in the interface collections, curators may recreate the appearance of a digitised artifact’s original site without immediate necessity for third-party production software. Accounting for the enacted narrative potential of collections, users can virtually experience the original site of digitised artifact through a curator’s careful organisation and positioning of artifacts. Curators may also arrange artifacts into virtual exhibitions for public engagement, in a similar manner to how one might approach real-world displays. When adopting artifact collections as evocative spaces, historians can depict monumental events through chronological or experiential placement of artifacts and their contextual media.

Outside of professional uses for collection customisation is opportunity for the public to use collection scenes as an authorship platform, communicating narratives unique to the owner. Understanding a digital artifact’s embedded narrative potential is an important aspect to public collection use, as it suggests collections figuratively acting as a ‘memory palace’ (Jenkins, 2007, p.58); where each artifact tells a story important to the user and their research or personal interests. Allowing for open curation aims, not only to encourage public engagement with cultural archives but to also allow for emergent narratives to arise; transforming archives into active producers of information previously unanticipated by institution authorities. With each collection qualifying as a figuration, open curation furthers the interface as a mode of production by allowing for artifactual recontextualisation, multiplicity, and transformation.

4.5.3 COLLECTION METADATA

Instead of compiling object information (already facilitated by the artifact XML schema), the collection XML schema hosts metadata describing the nature of collections and their authorship. Similar to the function of the artifact schema, this collection information is defined by user GUI
input and is used in contextual displays within the interface. Collection metadata is extended by describing spatial and transformation information of artifacts comprising a collection.

Further research into three-dimensional archive interfaces is required to explore further possibilities for the role of digital artifact collections. In addition to user-specific data for building social media attributes (such as user profiles), curatorial functionality may be expanded to include protected collections; allowing for team builds, collection access for specific audiences and other potential figurations of artifact collections.

4.6 USABILITY TESTING

Outside of interface development, valuable results from this research were obtained during software user testing. The trial participants undertook was structured to not only provide critical qualitative feedback on interface functionality but also, due to lack of widely adopted precedents, serve as an introduction into how the software operates. To this end, testing sessions were structured to begin with questions gauging first impressions, followed by directed tasks explaining the interface and extrapolating usability information, before ending with post-session questions acquiring qualitative feedback by summarising participant experience.

4.6.1 SOFTWARE FIRST IMPRESSIONS

Questions surrounding participant first impressions largely provided positive feedback about environment design, and suggested immediate recognition of the software’s role in facilitating interaction with three-dimensional digital media [see Appendix D for User Testing Impression Questions]. A number of participants commented on the presence of GUI navigation icons, used to move between the respective Artifact (also referred to as the ‘Import’ scene in this paper), Browse and Collection scenes. While these were understood to provide a level of differentiation between software functionality, some members anticipated these would toggle different representations of three-dimensional models (such as vertex, mesh and shaded model views); a common feature in three-dimensional media production software.

Impression questions also revealed a perceived demographic for the software; the majority indicating the primary audience to be younger in age (below 30 years old), noting probable appeal to those who have grown up around or are interested in computer games. One participant expanded upon this to suggest the software’s potential applicability for aiding those who struggle with researching and text-based education; offering an interactive alternative to obtaining information.
4.6.2 DIRECTED TASKS

In order to evaluate interface functionality a series of directed tasks were constructed around core elements of the interface [see Appendix E for User Testing Directed Tasks]. Tasks were designed to provide a series of scenarios which approached an equivalence to their real-world usage, facilitating authentic information on how users begin learning the system and any distractions or obstructions encountered whilst doing so. They did not, however, attempt to directly replicate in experiential terms; a factor precluded by the nature of testing and adoption of an abstract experimentalist device (Brown, 2012, p.67).

Immensely popular amongst user testing participants were gamified interaction elements present within the software. Ability to ‘fly’ and ‘run around’ objects within the environment proved to be favourable in participant feedback, with the ability to inspect artifacts deemed to be one of the software’s strengths. However, a number of participants noted that this interaction came at the expense of ‘immediacy’ and ‘efficiency’, a factor elaborated upon during post-session questioning.

Many participants particularly adept at using the system commented on their software intuition being derived from previous computer game experience; a core assumption made from the onset of this research. This very attribute proved to be a limitation for one participant lacking game experience, where the use of WASD standard gaming configuration was found to be foreign and unintuitive. This conflict reflects Suchman’s description of where multiple logics lead to incommensurate directions for system design (Suchman, 2012, p.52), but might have been mitigated by including instructional material within the software.

A common obstacle for participants first using the software was toggling between navigation and graphic user interface (GUI) modes of interaction. The divide between two-dimensional versus three-dimensional forms of interaction was a concept not immediately obvious to many of the participants. This lead to an expectation where they might interact with graphics (such as buttons and input fields) whilst navigating; a functional overlap previously discussed in this paper [see 4.2.2 - Browse Navigation]. Once reflecting upon this issue, the majority of the participants felt this functionality was ‘understandable’ and was just a matter of ‘getting used to it’; recognised as a reasonable learning curve when adopting a new software package.
As previously discussed in this paper [see 4.3.5 - Artifact Metadata], metadata standards were not of primary concern during software development; consequently, the Artifact scene of the interface provided a number of valuable suggestions for better suitability for institutional adoption. One participant fitting the Archiver persona complemented the system for describing artifacts as they are imported, and its inclusion of mesh-specific information. This functionality could be improved by introduction of versioning and download functionality; confirming directives planned for the software’s future development [see 5.1 - Recommendations].

4.6.3 POST-SESSION EVALUATION

Having completed directed tasks, participants evaluated their experience using the software and identified key issues encountered when adopting the system. Post-session questions posed an ideal opportunity for discussing with participants how introducing three-dimensional modes of archive interaction compared to previous experiences engaging with two-dimensional archives [see Appendix F for User Testing Post-Session Questions]. Focusing on shared aspects of functionality, information essential to easing this transition was acquired from participants.

A common theme in post-session feedback was an ability to engage with artifacts in novel and interesting ways; a primary instigator for conducting this research. Some participants opined they wouldn’t typically utilise institutional archives unless they had ‘specifically had something to look for’. By comparison, three-dimensional modes of engagement were perceived as ‘fun’ and encouraged ‘new perspectives’ on artifactual media. Significant within this feedback are comments identifying real-world metaphors integrated during system design; by simulating ‘physical’ forms of artifacts engagement (such as first-person perspectives, ability to move and rotate objects), three-dimensional archive interfaces look to ‘give back a lot of what is left out of digitisation’. It was further noted that this form of interaction was unique to the spatiality of the artifacts in the archive; where approaches adopted by the software were effective for three-dimensional objects, they would not be appropriate for two-dimensional media such as ‘books’.

One factor post-session questions brought to light was the role environment size plays when browsing in three-dimensional space. While similar to participants’ first impressions, there were immensely positive responses to the environment design; a number of participants commented on how the sizeable landscape artifacts were returned to from a browse query reduced efficiency while completing their tasks. The distance between artifacts, intended to facilitate exploratory forms of archive engagement, was in turn perceived to reduce workflow efficiency within the software;
another example of where accounting for multiple logics in the system can lead to incommensurate directions for system design.

Related to feedback on the previous point, responses from participants on their experience browsing in three-dimensional space frequently recommended adding two-dimensional images into the browsing process. A core restriction perceived by participants was the three-dimensional browsing process preventing users from efficiently assessing relevant results to find their desired artifact. This loss in ‘immediacy’ or ‘efficiency’ is thought to be potentially appeased by integrating a two-dimensional system during the browsing phase; in which users may refine the number of query results down using two-dimensional thumbnail images of relevant artifacts. The exact nature of how this process would function in reality is subject to further research and development.
Conclusion

The project discussed in this paper looks to provide a case for progressing beyond depicting digital three-dimensional media as two-dimensional counterparts within archive interfaces, towards an approach which appropriately represents three-dimensional artifacts and exploits the narrative potential this spatiality allows for.

By adoption of a gaming engine as the software framework for this archive interface, unique forms of artifactual engagement are able to emerge, allowing users to inspect, browse, and curate three-dimensional media in ways previously precluded by bounds of physicality or two-dimensional representation. This paper delineates aspects of narrative potential in artifacts and their surrounding environment possible through three-dimensional representation. By exploiting diegetic space intrinsic within interfaces, these environmental narratives become powerful tools for curators and the general public in communicating verified and anecdotal information.

Further research into exactly how three-dimensional considerations may fit into current archive interfacing processes, such as browsing and searching for media, is required before full implementation can be realised. However, based on the findings presented in this research and results derived from user testing, it is clear that there are endless opportunities for how three-dimensional media may provide a means for not only enabling access to artifacts but also reinvigorating their engagement with the public.

Before benefits from three-dimensional spatiality can be reaped, a shift in cultural institution practice and mentality is necessary. From the dawn of born-digital artifacts, physical materiality is no longer an effective metric for evaluating artifactual value. Nor, with the exponential growth of digital three-dimensional media production in cultural sectors, can born-digital media be expected to take form in two-dimensions. The three-dimensional digital artifact, while lacking physical corporeal status institutional curators may be accustomed to, warrant preservation as they contribute to shaping the modern cultural sphere. Omitting or spatially misrepresenting these artifacts within archive interfaces excludes potentially important information to the public and their collective cultural history.
By deriving attributes from the archive interface developed in this research, cultural institutions seek to move physical objects from inaccessible storage, and born-digital media currently not yet accounted for, into a space where user engagement with these artifacts may continue to shape a nation’s cultural memory and identity.

5.1 RECOMMENDATIONS

Acting as a case study for effectively representing digital artifacts within archive interfaces, the emphasis of this research has primarily been placed upon modes of engagement possible by the introduction of digital three-dimensional spatiality into cultural institution practice. However, due to the number of research avenues proffered by this premise, there are areas which lay beyond the bounds of feasible research conducted during this project.

5.1.1 ARCHIVE DEVELOPMENT

A core limitation of this research is into what databases housing digital three-dimensional artifacts would necessitate. The XML schema developed for this case study only houses information essential to interface functionality, including rudimentary artifactual, model and contextual information. By implementing a standard ontology, such as CIDOC’s CRM, this baseline information would be extended to include attributes such as catalogue and organisation information, as well as allowing further expression of relationships between artifacts.

Databases underlying archive interfaces would encompass research into systems for metadata ingestion and artifact tracking; exploring processes such as submission information packages (SIP) for tracking artifact submissions, and artifact information packages (AIP) for tracking changes to artifacts. By adding validation procedures into artifact submissions, processes for determining artifactual value can be implemented; helping create archival standards for attributes such as mesh and texture quality.

Mesh compression affecting the artifactual value of three-dimensional models is a prominent point of discussion in this paper; with this project siding on creative interactions over retention of original resolution. A compromise between the two perspectives may lie in an introduction of versioning functionality within the archive. Such a system might allow raw data (referred to as the Master or original), edited or compiled forms (Modified Master), and compressed, interface-ready (Access Derivative) versions, to each be housed in the archive database; mitigating the need to choose between creative interactions and artifact resolution.
Accounting for these archive considerations would drastically alter design and functionality created for the importing scene, as well as provide countless opportunities in the browsing and collections scenes. However, it is worth reiterating that the project discussed in this paper does not intend to provide thorough analysis of the archival processes for digital three-dimensional artifactual media, but rather serve as a case study for the effective engagement possible when interfacing with such media. A number of these limitations look to be addressed in development stages subsequent from this thesis research, where the current interface build looks to move from being situated within local environment to an online capacity with an underlying archive developed and trailed.

5.1.2 FURTHER INTERFACE DEVELOPMENT

In addition to research on the archives housing digital artifacts, are extensive research opportunities surrounding interfaces for engaging with archives which were either limited in the scope of this project or exceeded the bounds of research.

Accounting for various file formats, both in terms of three-dimensional graphics and contextual media, was a common topic throughout this paper. The Wavefront OBJ three-dimensional graphics format was selected for archive interface support due to its ubiquity and parsability. Further research should be undertaken into catering for industry-specific formats (such as .STL in computer-assisted manufacturing) and into potential from supporting complex formats such as Autodesk’s FBX package.

Similarly, to ensure feasible development and avoid potential codec licensing costs, formats for artifact contextual media were restricted to JPEG images with the Ogg container adopted for audio and videos. Research beyond this paper should explore how media may be pulled directly from existing archives to serve as artifact contextual media. As frequently mentioned throughout this research, born-digital artifacts are often dependent on an array of media types; including assets such as scripts and shaders. Further understanding as to how these attributes may be represented in archive interfaces would allow for more appropriate depiction of an artifact's original state.

Based upon the user testing conducted during this research, a common topic of feedback was the integration of two-dimensional modes of browsing alongside three-dimensional approaches. This is an area of limited research in the context of this case study and a field which certainly merits further exploration. By adopting aspects of two-dimensional browsing into system design, developers look
to reduce user learning curves when being introduced to the software, while enhancing workflow efficiency. It should be cautioned that this research should endeavour to not overlook benefits from new three-dimensionality approaches in favour of established two-dimensional forms; a compromise should be met.

One core advantage from using a framework such as Unity3D for the development of archive interfaces is the ability for cross-platform delivery; allowing development of layered experiences for user engagement with artifactual media. The interface of this research was developed as a standalone build, targeting local implementation of the software. However, Unity3D's platform flexibility provides scope for the interface to be equally deployed for web (via WebGL or Unity Webplayer builds), mobile, augmented and virtual reality purposes, or even retrofitted for gaming platforms such as Playstation and XBox consoles. Opportunities these modes of engagement may provide are certainly worth exploration as a means of exposing new audiences to the value of artifactual media.
References


VIRTUAL RECOLLECTION | Ryan Achten | Victoria University of Wellington Master of Design Innovation 41
Appendices

APPENDIX A  OPERATIONAL DEFINITIONS

Artifacts
The artifacts mentioned in this paper refer to three-dimensional digital objects and their supporting contextual information considered to be of artifactual value. This encompasses both virtual heritage models produced as a result of digitization of physical artifacts and born-digital media generated from creative outputs.

Browsing
In terms of the interface developed during this research, browsing is the process by which users may query for artifacts pertinent to their research or leisurely interests.

Contextual Relationships
Within the context of this research, contextual relationships refer to associations between various items of media within the archive (regardless of spatiality). These associations contain information which helps situate an artifact in time and space, as well as aid the user in understanding artifactual information. Within the interface, these associations become evident as a result of browsing, or when defined by the user in their collections. Such associations may be formed through the spatial positioning of various media (in order to reconstruct a digitised artifact original site or for narrative purposes) or by assignment of two-dimensional media in the artifact's contextual information fields during import.

Curating
Methods of curation mentioned within the hypotheses refer to how users (both inside and outside of institutional practice) may assemble digital artifacts into collections relevant to their own personal inquiries or to tell a wider, overarching narrative.

Material-Specific Information
Material-specific information is details about a given artifact that can only be uncovered through inspection of the artifact's material form (be it in physical or digital representation). Such information may relate to the contours of the artifacts physical form, or be identified through examination of details evident on the artifact's texture.

Navigation
The notion of navigation in the context of this research refers to the manner in which the archive user moves between different functionality provided by the interface. Within a platform which solely caters for two-dimensional artifacts and navigation, this is facilitated by the correlation between the user’s mouse and the cursor’s onscreen position. However, with the addition of depth into user interaction, this model for navigation is no longer appropriate for engaging with spatially-dependant functionality.

Users
The interface developed in the context of this research is aimed at a demographic which encompasses cultural institution professionals, creatives working in the realms of digital three-dimensional media and the general public. Cultural institution professionals, specifically curators and digital collections personnel, are anticipated to value the methods of attribution of metadata and their ability to curate digital objects. Creatives, specifically three-dimensional media designers and new media artists, are presumed to place emphasis on contribution functionality and archival representation of their media and its dependencies. The general public is of particular relevance to testing these hypotheses, as it is hoped they will provide insight as to the intuitiveness of navigating within three-dimensional platforms.

APPENDIX B  USER PERSONAS

Assumption personas developed from the rough demographics previously constructed.
Developed based upon the Lynda.com UX Design Techniques: Creating Personas course by Chris Nodder.

EXISTING USER DATA
The unprecedented nature of digital three-dimensional archive interfaces implemented by local cultural institutions in New Zealand, presents a number of issues when attempting to develop user-centric software.
For this reasons, analysis of quantitative data to see where users are struggling (usually required for the production of user personas) is not possible due to the absence of statistical data and metrics to extrapolate from. Similarly, qualitative user information useful to see why users are struggling in a given process is also difficult to acquire due to no existing use cases implemented locally for site visits and user observation.
While it may be argued that user information may be acquired from users of existing two-dimensional cultural institution archive interfaces, since the explicit nature of this research intends to explore the benefits of digital three-dimensional artifacts and their engagement using archive interfaces, this user data would not be directly valid or useful for the purposes of this research.

Instead the acquisition and analysis of user data has been reserved until after the development of a preliminary software prototype and its trial through usability testing.

USER PERSONAS
While an existing set of user information is generally considered necessary for the construction of user personas, seeing as this was not possible from the onset of the project’s development, a number of hypothetical assumption personas and their respective attributes were produced to help guide the development of the archive interface functionality.
INTERFACE USER PERSONAS

Persona 01: Annie the Archivist
Persona 02: Reece the Researcher
Persona 03: Denise the Designer
Persona 04: Margaret the Mother
Persona 05: Tony the Teen

PERSONA 01: ANNIE

“Annie the Archivist”
Occupation: Digital Archivist at Cultural Institution
Age: 36
Technology Comfort: 9 /10
Computer Game Experience: 5 /10
3D Digital Production Experience: 0 /10
Digital Archive Experience: 10 /10

CONTEXT

- Deals with databases and archive interfaces on a daily basis as a part of her position.
- Part of a team responsible for introducing institution digital artifacts into the archive database and attributing associative metadata.
- Has a general interest in digital technologies.
- Also plays computer games occasionally on her PC.

GOALS

- As part of her job, Annie needs to be able to import digital artifacts into the archive using the interface.
- Another aspect of Annie’s job requires her to attribute contextual information and metadata to the imported digital artifacts.
- She may also be required to produce institution digital collections of artifacts for public engagement based on the original locations the artifacts were retrieved from.
- Considers the ability for the public to virtually engage with digitised artifacts and three-dimensional collections the core benefits for introducing an interface such as this into their archive.

CONCERNS

- As Annie is doing these interface activities many times on a daily basis, being able to do these tasks quickly with minimal errors (efficiency and effectiveness) is a priority for her when using the interface.
- Concerned that the introduction of a three-dimensional interface is going to slow her workflow down compared to their current two-dimensional system.
- When required to recreate digitisation sites, some degree of precision is necessary when orientating various artifacts in the collections.
- Concerned at her ability to adopt the three-dimensional navigation system required to fulfill this task effectively.

PERSONA 02: REECE

“Reece the Researcher”
Occupation: Cultural Anthropology student (second year) at Victoria University of Wellington
Age: 21
Technology Comfort: 5 /10
Computer Game Experience: 8 /10
3D Digital Production Experience: 0 /10
Digital Archive Experience: 6 /10

CONTEXT

- Reece has some experience dealing with archives through his previous scholarly research, however these archives have largely been two-dimensional academic journal archives and online photographic collections.
- Currently completing his paper Culture and the Material World, Reece intends to use the interface to aid his research into the role of various objects in historical and contemporary Buddhist rituals.
- Primarily uses his laptop for word processing software and surfing the internet.
- However frequently plays FPS games on consoles such as PS3.

GOALS

- For the purposes of his research, Reece needs to be able to query the archive using the interface for three-dimensional digital artifacts relevant to his research interests.
- To keep these objects available for future reference, he also needs to be able to add objects to a collection saved for the purposes of his research.
- Furthermore, it would be great if this collection could be made to look presentable for him to demonstrate to his colleagues.
- During his studies, Reece may uncover information or contextual information that may be relevant to the artifacts not currently included in the archive. If this occurs, he is interested in updating the artifact information for others to use.
CONCERNS

- Needs to be able to effectively access artifacts relevant to his research interests
- Concerned that the addition of three-dimensions into the browsing system may affect this process as he has little knowledge about three-dimensional media
- Is concerned about how effectively he may be able to modify the appearance of the objects constituting his collection
- Also due to absence of three-dimensional media knowledge
- Reece is also worried that the collection he produces will not look good enough for him to confidently show his research findings to his peers

PERSONA 03: DENISE

"Denise the Designer"

Occupation: Animator and Motion Graphics Designer

Age: 29

Technology Comfort: 9/10

Computer Game Experience: 3/10

3D Digital Production Experience: 10/10

Digital Archive Experience: 2/10

CONTEXT

- Denise is looking to use the archive as a platform for preserving the media which have comprised her creative outputs whilst opening them up for remix and reinterpretation by other artists and designers.
- While she hasn't really had a lot to do with cultural institution archives before, Denise believes the models stored on her hard drive could be of value to others out there

GOALS

- Needs to be able to upload models to the archive using the interface
- She also wants to be able to store these in a collection of some kind of ease of reference
- Denise wants to also be able to assign video media to the models used in their production
- In addition to video media, many of her projects include other contextual media such as textual descriptions and images used for describing the overall project

CONCERNS

- Some of the media may be subject to copyright issues from various clients and stakeholders, Denise thinks that allowing for different Creative Commons designations may help mitigate many of these issues
- The ability for members of the public to effectively access video media the models were used for is a primary concern for Denise
- Presentation of video media will ideally allow for HD viewing, as to not obscure the creative output

PERSONA 04: MARGARET

"Margaret the Mother"

Occupation: Part time Secondary School Teacher and Mother of Tony

Age: 45

Technology Comfort: 2/10

Computer Game Experience: 0/10

3D Digital Production Experience: 0/10

Digital Archive Experience: 1/10

CONTEXT

- Margaret has recently come into possession of some family heirlooms she thinks may be of cultural or historical significance and sees the archive as an interesting opportunity to not only to create a digital backup of the objects, but also to be able to share them with her family and anyone else who may be of interest to them
- Margaret is reluctant to adopt new technologies outside of what her job requires of her
- However she also sees the potential for using the interface in the context of her classroom-related endeavors

GOALS

- Margaret's primary need for the interface is for her to be able to upload heirloom models to the archive
- She also wants her family and others to be able to view and inspect the artifacts virtually
- For ease of access, ideally her heirlooms will be able to be stored in a collection of some kind
- These family members may also want to add additional contextual information/media that she may not be aware of or have access to

CONCERNS

- Margaret is concerned about her ability to digitise heirlooms herself
- Wonders if this may be a service provided by the hosting institution
- Due to her (and other members of her family) being limited in technological abilities, she is also concerned about how intuitive the system will be for uploading and inspecting artifacts
PERSONA 05: TONY

“Tony the Teen”
Occupation: Year 11 Secondary School Student
Age: 16

Technology Comfort: 7 /10
Computer Game Experience: 10 /10
3D Digital Production Experience: 0 /10
Digital Archive Experience: 0 /10

CONTEXT

• Tony is interesting in using the interface as a research tool for his history class, where he may store digital artifacts he deems to be relevant to his various assignments
• Furthermore, Tony thinks that the interface could be an interesting platform for him and his friends to construct fictitious worlds using the objects available in the archive

GOALS

• Tony needs to be able to query the archive for artifacts relevant to his history assignment research interests
• However he also wants to be able to browse the archive less directly for objects that may be of interest to him and his friends
• He also wants to be able to create collections of objects for presenting to his class
• The objects in the collections Tony and his friends want to produce, need to be able to be modified in terms of scale and position to be able to become interesting virtual worlds

CONCERNS

• If the collections can’t be made to appear interesting, Tony and his friends won’t be too keen to engage with the system; instead adopting other virtual creation tools
• Furthermore, the virtual worlds they create need to have some form of interesting interactivity to keep them engaged
The thesis project Virtual Recollection was produced through many stages of development and iterations before the final research outputs and software were realised.

This document looks to give an overview of this development and provide insight into conceptualisation processes underlying various design decisions.
Prior to undertaking thesis research, this project was preceded by the Victoria University of Wellington Summer Scholarship, Digital Archive of the Future. In collaboration with the National Library of New Zealand, this project looked to investigate the potential role of three-dimensional media in library and archive practice. As a result, a number of speculative concepts were designed and proposed to the staff to act as catalysts for conversation around the topic. Notable amongst these is the My National Library, which outlined a visitor experience with similar sympathies to this project’s direction.
DIGITISATION

Methodology

Medium specificity directs script and story. Codes are formed, supplemented, simplified, or reimagined

How the work amphibian

Gradual emergence as user’s interactions and convergence

Dependent identity between the interface and the user’s trajectory and identity

How can symbolic elements create meaning?

Initial Research Areas

ARCHIVE

Initial Thesis Research Areas

INTERFACE

Virtual Recollection: The interaction of archival media with digital objects in virtual environments

How can the audience access and interact with archival objects in virtual environments?

How can the audience interact with the archival objects and virtual environments to stimulate memory?

How can digital objects be re-created and maintained to make accessible to wider public?

Create active memories by ‘activating’ archived memory through design intervention and cultural interfaces

DIGITISATION

Memories stabilised through the use of symbolic forms of commemoration (material & procedural)

Symbolic forms of commemoration can infinitely extend the temporal range of memories

How can archive interfaces act as procedural forms of commemoration within social memory?

What are the advantages of using 3D scans as material forms of commemoration?

This incurs a loss in generational experience

How can this loss begin to be mitigated via design intervention?

Transform ephemeral social memory into collective memory via organisation and elaboration

Ephemeral social memory mediated through 3D scanned representation.

Organisation and elaboration takes place through the archival, mediating and public engagement of resulting 3D scanned digital objects

ACTIVE FORMS OF CULTURAL MEMORY

Active forms of cultural memory re-created and maintained to make accessible to wider public

Create active memories by ‘activating’ archived memory through design intervention and cultural interfaces

Humans acquire memories not only through lived experiences but also via interacting, communicating, learning, identifying, and appropriating

TOP

BOTTOM
The initial scope of this project sought to include an entire digitisation pipeline; encompassing the photogrammetry process through to the storage and engagement with the digitised artifacts.

This scope proved to be much too ambitious later in the project, however, some early photogrammetry pipelines were developed using both proprietary and open software with Bash scripting for automation. These test scans were cleaned in software such as MeshLab and Cinema4D before being used to trial high-polygon count models within the interface.

**Photogrammetric scanning studies**

**PREVIOUS**
Photogrammetric Scan Trials

**TOP**
Photogrammetric Proprietary Pipeline ~ *Using Agisoft PhotoScan*

**BOTTOM**
Photogrammetric Open Pipeline ~ *Using VisualSFM*
Christchurch Cathedral
Pre-quake
(Flickr)
Source Photos: 176 JPG
Tri Count: 414,646

Christchurch Cathedral
Post-quake
(Instagram)
Source Photos: 57 JPG
Tri Count: 60,000

Source Photos: 57 JPG
Tri Count: 60,000
PREVIOUS
Found Media Phtogrammetric Test ~ Sourced from Flickr and Instagram

CURRENT PAGE
Early Environment Mock-Up ~ Rendered in Cinema4D
Artefact Photogram
Photogrammetric scan of a physical object. These could be derived from an artefact housed in institution collections or an object of the general public.

Differentiates from Place/ Monument photograms due to emphasis on smaller objects.

Place/Monument Photogram
Photogrammetric scan of a physical places and monuments.

These scans could be comprised of location-based scans of places (including buildings exteriors and interiors, outdoor environments etc) or monuments (such as statues, sculptures etc).

Hybrid Photogram
The process of photogrammetry can (to varying extents) be applied to existing 2D visual media such as photographic records.

While these models could be divided in the above categories, this is a distinction that should be made evident as these hybrid scans lend themselves well to retaining temporal information as well as spatial data.
TOP
CRM / Interface Communication Development

BOTTOM
Interface Metadata Construct Mapping Development
To anticipate how users will adopt the Vertice software, a number of user experience exercises were undertaken.

User goals and concerns for using the software were derived from assumptive user personas. These were grouped into tasks and then abstracted further into events which provided the foundations for scenes within the software. Software events, tasks and goals were laid out in a user experience map, from which user experience models were extrapolated.
USER EXPERIENCE MAPS

The user experience maps featured here were produced by creating scenarios based upon the user personas used in the in-situ studies of the project.

Each shape in the scenarios was then placed below the area of the interface the activities in the scenario and being played, allowing for the user pathways through the interface to become visible and for communication between different use cases to be identified.

USER MODEL 01 - CONTRIBUTORS

The user models were derived from communities between the various interface pathways present within different user scenarios. These communities are useful for anticipating what the user demographic will be primarily using the interface for.

The first of these user models are the contributors who primarily use the interface to explore artifacts (either personal, occupational or historical) via the underlying archives. These users also frequently use the collection functionality to create collections of artifacts to share with others.

The contributors making up this model are archivists, curators and the general public.

USER MODEL 02 - RESEARCHERS

The second of these user models are the researchers whose primary use for the interface is using the browse scene to find artifacts relevant to their research or Healey interests. They too use the collection scene, how is this to collect objects of interest to them and their friends groups as opposed to collecting artifacts that they themselves have uploaded.

The researchers making up this model are researchers, students and the general public.
**PRESERVED MESH INFORMATION**

[Photogrammetric Artifact Sample]

![Pie charts illustrating the percentage of vertices and faces preserved in the mesh.](image)

**PHOTOGRAMMETRIC VERTICES AND FACES PRESERVED IN INTERFACE**

![Bar charts and pie chart showing the percentage of vertices and faces preserved in the mesh.](image)

**FILE SIZE ARTIFACT FILE SIZE PRESERVED IN INTERFACE**

[Artifact Sample]

![Bar graph illustrating the file size of different artifacts.](image)
During the software development, it was essential that the performance of the software was trailed against different types and resolutions of three-dimensional models. Data such as file size, vertex and polygon counts, and return time were each recorded to get an idea of the software’s parsing performance and the degree of compression required from artifacts it imports.
interface functionality dev.

TOP
User Navigation ~ Artifact Scene

NEXT TOP
Artifact Importing ~ Development 01

NEXT MIDDLE
Artifact Importing ~ Development 02

NEXT BOTTOM
Interface Metadata Communication Development

Core functionality for the interface required extensive planning and modelling before implementation.

Aspects such as metadata communication, browsing systems, curation methods were mapped out prior to developing Unity tests.
General Search

Refined Search

Search refined by selecting the appropriate field checkbox they think their query is assigned to; these include:
- Object Name Info
- Person Name Info
- Date Info

Searches entire XML document for node innerText that matches user input and returns relevant media.

Browse by Creation Type

Creation type is currently divided into five categories during import: photogrammetry, design, architecture and new media. Represented in the browsing scene as drop down buttons. Returns a list of matching media.

02 - OBJECT INFORMATION
VIRTUAL RECOLLECTION / Project Documentation
browse scene dev.

**Move Character**
- Move Forward: [W Key]
- Move Back: [S Key]
- Move Left: [A Key]
- Move Right: [D Key]
- Speed Up/Down: [MMB]
- Speed Up/Down Increases / decreases max walk speed + jump velocity
- Select: [LMB]
- Select as Active (?): [LMB]
- Zoom In / Out: [MMB + RMB]
- Zooms camera in and out
- Zoom In / Out: [MMB]
- Zooms camera in and out
- Rotate Cam
  - X Rotate: [Mouse Y pos]
  - Y Rotate: [Mouse X pos]
- Jump/Fly: [Tab]
  - Jump or fly for view
- Browse Menu: [Tab]
  - Toggle Browse Menu
- User Navigation ~ Browse Scene

**TOP**
Browse Scene

**NEXT TOP**
Browse Grouping ~ Development 01

**NEXT MIDDLE**
Browse Grouping ~ Development 02

**NEXT BOTTOM**
Browse Grouping ~ Development 03
Modify Method 01

Scale/Position/Rotate using modify panel GUI. Scaling can be achieved using relative scale or by defining dimensions (constrained for uniform scaling).

Modify Method 02

Scale/Position/Rotate using shortcuts T/E/R respectively and mouse position to allow for intuitive modification of artifacts.
After core functionality was largely completed, the software urgently needed to move beyond default GUI assets. The first step in this process was deciding what layout would cater for user experience and interaction needs most effectively.

A number of wireframes were produced during this phases, connecting user experience with functionality developed for the software.
GUI_REDEV WIREFRAMES  |  UPDATED ARTIFACT SCENE

TOP
Artifact Scene ~ *Prior to Redesign*

BOTTOM
Artifact Scene ~ *Redesign Wireframe*
GUI_REDEV WIREFRAMES : UPDATED COLLECTION SCENE

TOP
Collection Scene ~ Prior to Redesign

BOTTOM
Collection Scene ~ Redesign Wireframe
Having outlined rough wireframes, these layouts were refined further through project colour schemes and branding exercises.

Beginning with 2D sketches in Illustrator, the final branding icons was produced in Cinema4D and applied throughout the software.
TOP
GUI Development ~ Branding Concept 01

MIDDLE
GUI Development ~ Branding Concept 02

BOTTOM
GUI Development ~ Branding Concept 03
TOP
GUI Development ~ *Browse Scene*

MIDDLE
GUI Development ~ *Artifact Scene*

BOTTOM
GUI Development ~ *Collection Scene*
TOP
GUI Development ~ Browse Scene

MIDDLE
GUI Development ~ Artifact Scene

BOTTOM
GUI Development ~ Collection Scene
interface environment design

**TOP**
Terrain Development ~ *Browse Scene*

**BOTTOM**
Terrain Development ~ *Collection Scene*

The final phase in the software’s aesthetic development was designing the interface environment. Through the use of terrain and particle systems, the diegetic space could be exploited to a much greater potential.

Branding elements played an important role in informing design decisions as they were used to generate terrain heightmaps and act as portals between scenes.
Virtual Recollection
Ryan Achten
Victoria University of Wellington
Master of Design Innovation

Browse Scene ~ Final
Collection Scene ~ Final
Archive database development
Implement industry metadata standards
Aid in moving the software into an online service
Setup server requirements

Virtual reality (VR) / Augmented reality (AR) artifact engagement using hardware such as the Oculus Rift and software such as Vuforia

Smart replica (three-dimensional prints of scanned artifacts containing microcontrollers / AR technology) printing and software for communicating with the interface described in this proposal.

Scanning software for automating scanning of physical artifacts from beginning to end, including tools for synchronising camera movement, creating three-dimensional models and producing archive-ready digital artifacts

Outside of the scope of this MDI paper, this project has been granted VicLink funding for commercialisation of the software. This will largely revolve around employing external expertise to develop the project towards a market-ready product.

To achieve this, systems such as CIDOC’s CRM metadata ontology and versioning functionality will be implemented, and the entire software deployed for web and virtual reality platforms.
VIRTUAL RECOLLECTION

Ryan Achten

~

2015-16

Victoria University of Wellington / Master of Design Innovation