Curatorial Insecurity: The impact of 3D scanning and printing on curatorial practice

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Candidate Declaration

I hereby declare that:

1. I have not been enrolled for another award of the University, or other academic or professional organisation, whilst undertaking my research degree.

2. None of the material contained in the thesis has been used in any other submission for an academic award.

3. I am aware of and understand the University's policy on plagiarism and certify that this thesis is my own work. The use of all published or other sources of material consulted have been properly and fully acknowledged.

4. The work undertaken towards the thesis has been conducted in accordance with the SHU Principles of Integrity in Research and the SHU Research Ethics Policy.

5. The word count of the thesis is 41,236.

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Abstract

This thesis is situated in the field of digital cultural heritage and uses 3D scanning and printing as both a method and a provocation to reveal the curatorial process while simultaneously examining how the technology affects museum practice from the perspective of the museum curator. 3D scanning and printing (henceforth 3DSP) has become a keen area of interest among museum practitioners and researchers. The ever-increasing accessibility of 3D technology opens up new possibilities for audiences and curators alike, with the potential to establish new structures of practice and engagement. Yet despite the growing interest in 3DSP, very little is known about how integration of 3DSP does and could affect museum practice and its traditional methods of working.

This thesis will investigate how and why 3DSP is affecting the practices and traditions of the museum from the perspective of the curator, a member of staff who is arguably the first and primary engager with museum objects. The research undertaken for this study will focus on two museums, Museums Sheffield and The British Museum, to provide an account of how 3DSP affects curatorial practice when it is first introduced and an account of cases where 3DSP is already in operation.

The reader is first introduced to the concept of the 3DSP and its surrounding literature in the contextual review. The chapter acknowledges that 3DSP is relatively new within the museum sector and that such a novelty impacts on the breadth and depth of heritage sector literature on 3DSP. The contextual review thus provides a background to museum discourse before discussing the changing role of the museum curator. The literature concerning 3DSP in the museum is positioned and examined as a tool for simultaneously frustrating and supporting the role of the museum and its curators.

With the above arguments in mind, the thesis then moves on to discuss the methods and data used to examine 3DSP in the museum. Drawing on curatorial museum-based methods conducted over the past 3 years, this thesis details the perceived effect of 3DSP on museum practice and traditions. Daily tasks, such as planning exhibition concepts, accessioning and object research are reinterpreted as methods for this study, with the aim of understanding not only the role of the museum curator, but also how 3DSP impacts on the practice of museum curators.

By situating 3DSP at the heart of this study and working with pre-existing 3DSP projects, this study provides real-world practice examples of how the integration of 3DSP affects the museum.

At the centre of this thesis are three discussion chapters which examine the data gathered from an Acclimatisation Study and two curatorial residencies at Museums Sheffield and The British Museum. The chapters examine the curatorial positionality of 3DSP, where 3DSP sits with the museum structure and politics, and finally the digital implications of introducing 3DSP into the museum. Across all three chapters there is an attempt to position 3DSP within the wider narrative of digital cultural heritage, examining, for example, 3DSP's effect on our current understanding of authenticity and authority.

The first of the discussion chapters focuses on the curatorial intention and seeks to understand the perceived role and position of 3DSP in the museum. The chapter examines how participating curators from Museums Sheffield and The British Museum and their curatorial departments have responded to 3DSP and how their curatorial position could either work with or against the framework of the museum.

In the second discussion chapter the focus is on where 3DSP objects sit within in the museum. The chapter reveals the changes, frustrations and enrichments 3DSP has brought to curatorial practice and makes comparisons with alternative replicas, which have formed part of museum practice for decades. The material and immaterial properties of 3DSP museum objects are discussed in the chapter and applied to how curators believe this impacts on the object's sense of authenticity and authority.

In the final discussion chapter, the focus is on the digital challenges and benefits of introducing 3DSP into the practices of the museum. The chapter explores how curators responded to the introduction of 3DSP and furthers discussions from the first chapter. Within this chapter are examinations of how 3DSP affects copyright law, debates concerning how to treat data points added by the scanning software, and data storage concerns.

The conclusions, detailed in this thesis, reveal complex and shifting perceptions on the role and position of 3DSP within the museum that is interlinked with the museum's practice and traditions. Preconceptions exist about the use of the replica and its potential frustration of

museums' objects' authenticity as well as the transformations of digital objects and their use beyond the collection.

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'And yet… something about the modern technology- and the sense of being compared to other scanned objects (from Egyptian and Roman worlds), brings out a sense curatorial insecurity'. (Neil Wilkin- The British Museum).

1. Introduction

I sit at the desk of my first curatorial job. In front of me is the layout for the next exhibition, a list of object inquiries and a couple of accession forms. As I settle into a typical day as a curatorial assistant, the museum director walks into the office, approaches my desk and states: 'You know about computers. Set up a 3D printing project for which we can probably get funding'. I remember nodding with a confused expression on my face and thinking: 'I know how to work the database' and 'what is 3D printing?'

This day was the start of my research journey into how 3D scanning and printing affects the practices of the museum. While the project was a success, thanks to a collaboration with Google Cultural Institute, I realised that 3D printing had become a new buzz word in the cultural sector and that museums across the country were working on their own 3D scanning and printing projects for which there was the prospect of securing funding.

I became interested in how the integration of 3D scanning and printing would impact on the practices of curators and their behaviour. I began to see how 3D scanning and printing was more than the next technological fad. It had potential applications beyond exciting audiences and could, in fact, be used to help support the museums' core functions of object research, audience engagement and the conservation of artefacts.

I began using 3D scanning and printing as a research method. The more I learnt about the technology and its capacity, the more I saw the potential benefits of using the technology in the museum. Yet, at the same time, I could also see the challenges that 3D scanning and printing could pose to both the practices of curators and those engaging with it.

In today's museological environment, specialist curatorial knowledge and the roles associated with that knowledge are threatened by cuts to cultural funding, the rise of digital and online collections, broader interpretational perspectives (Caines 2012) and a narrative that favours audience engagement (see Weaver 2019). As such, the role of the curator is changing in order to comply with the expectations and demands of museum audiences and stakeholders. As Miller (2012) argues, the days of the specialist museum curator may be over but it does not pay to overlook the importance of specialist curatorial knowledge.

From a personal perspective I am frustrated by the lack of support from industry for the curatorial role. Yet at the same time I am curious about how the introduction of new technology can support curatorial practice, particularly in regional and independent museums who have seen the rise of the 'Do it yourself curator'

This thesis is the next step of my journey in researching how 3D scanning and printing impacts on the practices of the museum. Within this thesis, I seek to understand how the technology impacts on the museum from the perspective of the curator. I am trying to understand how curators, who are arguably the primary interpreters of objects, perceive the impact this technology has on the museum. Embedded within this question are potential frustrations of traditional practice and power, as well as positive developments towards object engagement and research.

1.1 Research Context.

The proliferation of technologies within the cultural heritage sector has long been documented, (Keene 2006, Cameron and Kenderdine 2010, Smith Bautista, 2013) from conservation to audience engagement, to research. Yet the relationship between museums and technology has not always been an easy one. As Janes (1997) writes, the museum of the future must be planned yet flexible, differentiated yet integrated and use technology, while allowing respect for objects. At the heart of the use of technology within the museum is the need to reconcile what heritage professionals have always considered as opposites (Janes 1997). Here, histories of traditional practice and the role of preserving objects for further generations are being challenged by the need to innovate.

The use of 3D scanning and printing in the museum (3DSP) presents a challenge that plays directly into the above paradox as, for the first-time, museums and their curators have the opportunity to replicate rapidly objects within the museum. Such a notion has the potential to challenge the very nature of the museum, for a large amount of time and effort is spent on ensuring that the objects included in their collection are neither replicas nor forgeries (Hien 2000). Here, the dilemma that museum professionals face is clear: by using 3DSP to create replica museum objects, the museum can enhance its object handling and its audience engagement offering. Yet, at the same time, replicating the museum object can be seen as challenging the very idea of an authentic museum object. This challenge is not confined to the act of copying museum objects but is centered around how 3D digital content is

interpreted and disseminated. Digital objects can be manipulated and augmented in ways that a physical object cannot, potentially enabling the democratisation of heritage and shifting authority away from the museum.

To date, 3DSP has already been of great interest to museums (Matello A, Rossi V 2011, Solima et al. 2016) but its potential and its impact have yet to be fully realised. Museums and heritage professionals are using 3DSP to support audience engagement (Stephens 2013, 2013b) visitor experience, collections' management, education and outreach work. Interactive exhibitions (The Science Museum 2014), downloadable models (Sketchfab 2015), and audience workshops (The British Museum 2014), all seek to engage audiences through the applications of 3D technology. Yet there is little real understanding of how the technology affects the museum and the practice of museum professionals.

3DSP has opened up new ways for museums to engage with audiences (see The British Museum 2013) and conduct object-based research (see Wachowiak and Karas 2009 and Bandeira et al 2013). Nevertheless, integrating 3DSP technologies in a way that complements, enriches and supports the practices of the museum remains an emerging field of research that raises concerns for museum professionals wanting to engage with 3DSP technology. Furthermore, there is no academic or practice-based research that details how museum curators cope with their emerging role of integrating and using 3DSP technology within their practice.

In fact, there is very little academic literature that examines how 3DSP could and does affect the practices and traditions of the museum and its curators. As I further detail in the contextual review, the majority of the literature on 3DSP in the museum is process based, (see Friess 2010 for an example of how 3DSP is described and evaluated in the museum setting) documenting the stages in achieving accurate scientific 3D scans which can be used to support object-based research. The literature ignores the impact that engaging with this technology has on museum practice and its curators, a key concern that needs addressing given that the curator is the first and primary person to engage with an object when it comes into the museum (Dudley 2009).

It is essential, then, to understand how museum curators respond and perceive the integration of 3DSP into their practice, if we are to better understand the potential of digital technologies within cultural heritage and museum practices in general.

In order to answer the research question mentioned above, the following aims and objectives were pursued.

1.2 Research Aims and Objectives

The research question for this thesis is:

How 3D scanning and printing affects museum practice and tradition, as expressed through curatorial practice?

1.21 Aims

Aim 1. To understand the motivations and barriers surrounding the integration of 3DSP into the museum environment.

Aim 2. To explore how curators, perceive the physical and immaterial properties of 3DSP.

Aim 3. To explore how curators' perceptions of making and using 3DP impact on the value of the print and the understanding of the original artefact in the museum.

Aim 4. To ascertain how curators' understanding and responses to 3DP may be framed by and affect the regional national and international museum context.

Aim 5. To enable curators to reflect on their role and the impact that 3DSP has on their individual way of curating their collection

1.22 Objectives

- To draw on literature from curation, museology and 3DSP technology in order to form an account of where 3DSP processes sit in relation to audience, practice and policy.
- To establish residencies with 2 different museums that were already dealing with 3DSP and that had different scales, curatorial structures, relationships to policy, etc.
- To devise and undertake a series of experimental methods with curators, using existing curatorial processes to capture directly the relationship between original object, scan and 3D print.
- To explore the use of exhibition making as a research strategy.

- To generate a series of artefacts and documented experiments that articulate the relationship between the curator and the artefact.

1.3 Thesis Structure

There are eight chapters in this thesis, including Ch.1 'Introduction' which exists to introduce the reader to the context in which 3DSP exists within the museum and the role of the curator and the structures of the thesis. Ch.2 is the 'Contextual Review', which examines the contextual frameworks in which 3DSP exists, before exploring the literature, both practical and academic, discussing 3DSP in the museum. For the purposes of clarity, the literature surrounding 3D scanning and printing has been separated as they have developed in different museum environments.

Ch.3 and 4 are the 'Method' and 'Data Reflections'. They describe the nature of this qualitative, practice-based research and document the three phases of research. The chapters describe, in detail, the methods I have used and the rationale behind my choices. Ch.3 documents the curatorial practice approach of each phase and Ch.4 describes the scope and form of data collected. Ch.4 is a predominately visual chapter with images of the 3D scans, completed curatorial interventions from each curator, and 'The Curators Box'. Here attention must be drawn to the fact that the Practical Submission accompanies the thesis and is a visual record of all the work completed. It is referred to throughout this thesis and should be read in conjunction with the research. The practice-based submission provides an additional personal narrative that supports the thesis and gives context to the work produced.

The last three chapters in this thesis examine and discuss the data and explore how 3DSP affects curatorial practice. Ch.5 is the first of the discussion chapters and examines the positionality of participating curators from across Museums Sheffield and The British Museum. It critically examines how curators perceive and position 3DSP within the museum and the effect this has on the way they curate with the technology.

Ch.6 is an examination of the frustrations, challenges and enrichments 3DSP could bring to curatorial practice. It examines the notions of play and curatorial experimentations, and investigates how 3DSP sits within the policies and structures of the museum.

Ch.7 is the final discussion chapter and examines the technological aspects of using 3DSP within the museum, including its challenges and its benefits. It examines how the museum and its curators wish to store and document 3DSP content and the intellectual property rights associated with sharing and disseminating 3DSP museum content. Despite Ch.5, 6 and 7 being distinctly different discussions, concepts such as the perceived authenticity of the objects and curatorial engagement run throughout all three chapters.

Ch.8 is the final chapter and documents the conclusion, contributions and limitations of this thesis. It concludes the arguments and findings of the thesis linking them to the aims and objectives mentioned at the start of this chapter. Here the limitations of this research and contributions this thesis brings to knowledge are discussed alongside possibilities for future research.

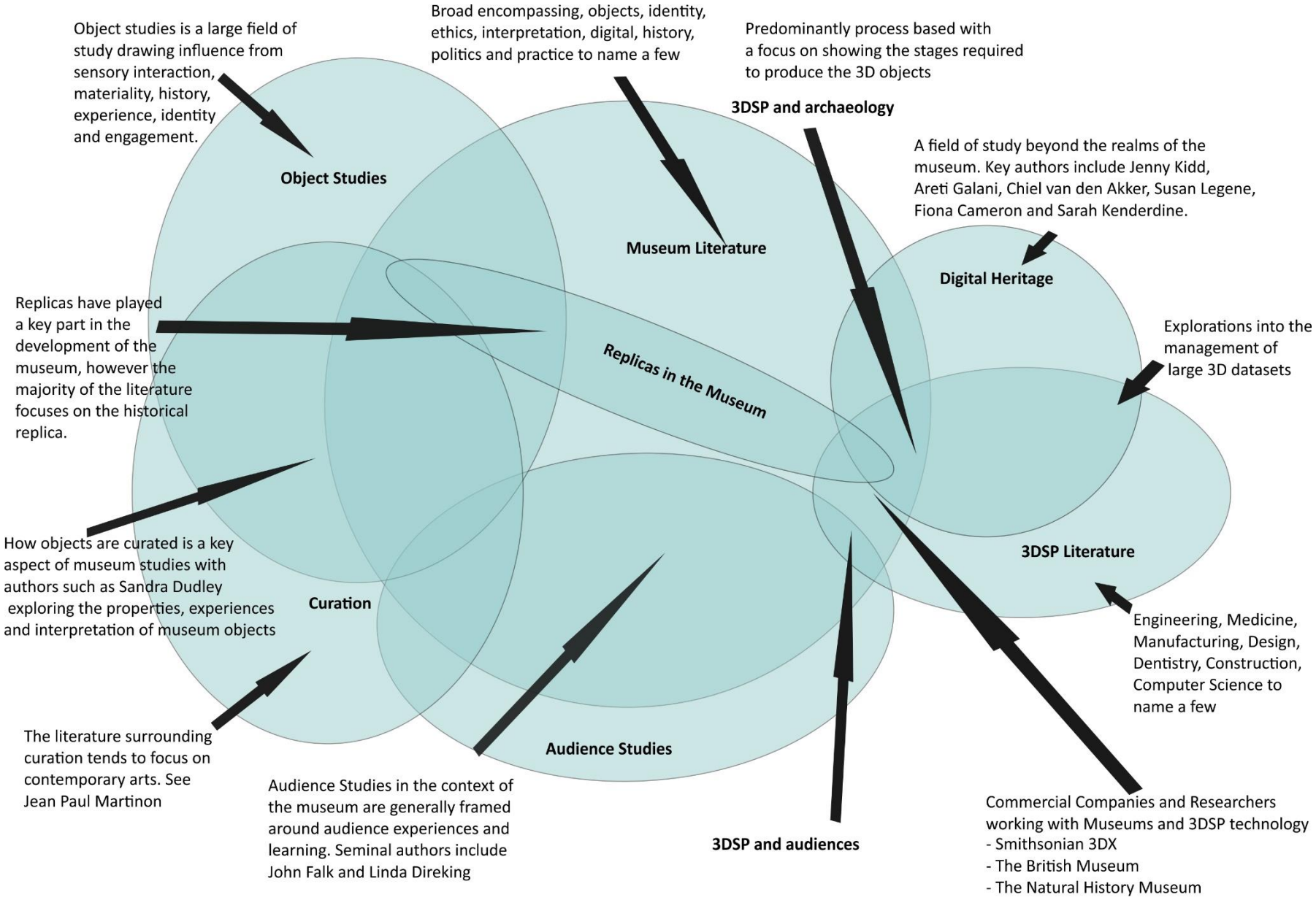


Figure 1 A visualisation of the fields of study explored in the contextual review

2. 3DSP in Context and Practice: A Contextual Review

2.1 Introduction

In this chapter I outline relevant and key discussions surrounding 3DSP in the museum. I attempt to highlight gaps in academic knowledge through a detailed analysis and review of academic, museum and industry literature on the use of 3DSP in the museum. It is acknowledged that 3DSP is relatively new within the museum field and, as a result, the literature has not yet fully emerged or become grounded within the domain of museums. There are, therefore, areas detailed below where little or no academic literature has as yet emerged.

I will first discuss the emergence of the museum from its conception to the role and significance that it plays in the construction of heritage today. This literature is then followed by an examination of the role of museum curators who are, arguably, key instigators in the value, judgements and significance assigned to museum objects. I will then discuss the role of replicas in the museum, before reviewing the available literature on 3D scanning and printing and how this technology is being used in the museum. It is important to mention that each section will not discuss the entirety of each subject outlined but focus on how 3DSP engages with these issues. That said, each section will attempt to position each subject and 3DSP within the context of the museum. Figure 1 is a visualisation of the fields of study explored in the contextual review and how they relate to one another. The illustration shows how fields of study overlap and form subject specialities. These are shown on the illustration with a brief account of the field and key subject authors.

2.2 An Overview of Heritage Discourse

The term 'Heritage' is synonymous with a reification of the past (Kidd 2011). It represents manifestations of memory, objecthood, materiality and intangible culture. Yet, while history and heritage may be interlinked, it is important to distinguish between them, especially within the context of the museum. As Lowenthal (1998) argues, heritage is demonstrated in ways completely different from history. There is a practice to heritage, established through acts of a community's intangible heritage or an individual's personal relationship to space. The worth of heritage cannot then be measured by critical or scientific tests but by its current and personal potency.

Heritage as a discourse began during the 1980s with increased critical engagement culminating in LauraJane Smith's Heritage manifesto (2012) and the formation of the Association of Critical Heritage Studies (ACHS). Yet heritage as a concept is not a neatly defined construct, with leading museum researchers and practitioners debating whether heritage and, as a consequence, the museum should remain true to its traditional practices or evolve with current discourses. Contemporary practitioners such as Harrison argue that heritage is a creative engagement with the past (2013) giving the impression that heritage exists in a 'historical state' accessible through active engagement. Yet, from a personal perspective, such a definition does not take into account the changes heritage items (objects, intangible acts, buildings, etc.) go through. This is a point which is supported by Smith (2010), who argues that heritage is not only a physical thing but more a of process, e.g. an act of communication and meaning making.

This communication and meaning making is seen through the rise of digital technology in the museum, which seems to align naturally with notions of ACHS in that its uses have come to support the creation of audience led content, (Lang, et al. 2006) increased access to collections and the democratisation of heritage, to name but a few. Embedded technology, along with 3DSP, is also being used to support personalisation within the heritage sector (Not, et al. 2017) enabling audiences not only to gain access to multiple layers of content but also to do so in a way that is meaningful to them.

The rise of digital heritage has certainly been a factor in the changing role of museums (Cameron and Kenderdine 2010, Benardou et al. 2018). Audiences have come to expect digital media within the museum setting. Online digital imagery not only acts as a point of reference to those in the know but seeks to increase access to heritage for those who cannot travel to the museum. This moves the museum beyond the building and brings it into the homes, schools and communities of the wider public as a means of generating greater access.

2.21 The Museum

Although the museum and, to a certain extent, heritage as a whole is undergoing a new wave of critical engagement, especially with regard to digital cultural heritage, this is not a new phenomenon. Since its conception, the museum has been at the centre of heritage construction, a social and political 'tour de force' shaping and constructing our understanding

of the past and our experiences of heritage. The museum has long been seen by the 'intellectual and capital bourgeoisie' (Gramsci 1997, Olsaretti 2014) as a tool for social improvement and as a civilising discipline (Miller and Yudice 2002) from the Education for All Act of 1902 to UNESCO's World Heritage.

Today, the museum is an institution that has a 'regime of care' (Harrison 2014) for a collection of artefacts, documents, digital works and other objects of artistic, cultural, historical, or scientific importance (Alexander and Alexander 2008) and its conception (Hien 2000), changing role (Anderson (2004), objecthood (Dudley 2010) and context (Carbonell 2004) have long been documented. Yet, as these texts reveal, the museum is not an isolated phenomenon. It sits at the very heart of heritage construction and, as a result, operates within a deeply political (Luke 2003), social (Falk and Dierking 1992) and environmental sphere (Giebelhausen 2003).

As Witcomb (2003) argues, the last ten years or so have centred on a heated debate between those who assert that the museum needs to change and those who maintain it should defend its traditional practice, a debate that has come to be known as Authoritative Heritage Discourse vs Critical Heritage Studies (Smith 2010). This debate is the result of the profound changes to museum culture (Miles and Zavala 1994). Museum founders saw the museum as a glorification and reification of genteel notions of civilisation (Handler 1987), whereas today museums are seen as settings for the social life of things (Henning 2006), experience (Miles and Zavala 1994) and the fostering of social identity (Macdonald and Fyfe 1998) to name but a few of its many new characteristics. Such a broad definition of what heritage is and can be makes it difficult for a concise definition to be conceptualised.

As a result, few texts address what the museum actually is and its significance within a global, environmental and societal concept, perhaps out of fear of generalisation or simply that the museological field has become so encompassing that the task has become almost impossible. On the back of this new museological criticism, Thomas writes

> '*Yet the voluminous writings and various writings seem not to address or account for the formidable importance that museums have assumed – almost unexpectantly given, how commonly it was though, until just recently, that the efflorescence of digital culture would render physical collections and museum visits redundant*' (2016:8)

Thomas assumes that the integration of digital technology within the museum is supposed to democratise and end the hegemony of authorised culture in heritage. On the surface, it has certainly changed the very nature of what the museum was, with museum managers adopting digitisation systems, Virtual and Augmented Reality tools, interactive exhibits, and countless other technology-led innovations deemed as institution-saving mechanisms. Yet the actual applications of digital technology have not always been used to serve access within heritage, with institutions holding on to digital outputs citing concerns over cultural sensitives, copyright and intellectual property rights. The actual uses of digital technology and whether the museum uses them to increase access to heritage needs to be a key area of investigation and is something which this thesis will seek to examine, with 3DSP as its focus.

While it is clear that digital culture has had a profound impact on the museum and the wider cultural sector (Bakhshi and Thorsby 2012), it is vital to document what the museum does to assume this 'formidable importance'. As Preziosi (2006), argues we live in a profoundly museological world – a world that in no small way is a product and effect of two centuries of museological mediations. These mediations are by no means neutral and often favour Western notions of art and culture.

At the forefront of the museum discourse and thus of the assumption of Western superiority, is the collection and its categorising practices (Keene 2006). As Witcomb (2003) argues, the collection is in itself a reification of the power, politics and sociality of the museum. Historically, and even today, the collection is designed with constructed taxonomies, which are in turn supported by historical frameworks popularising Western Civilisation as the pinnacle of society. It is through the collection that the function of the museum and its relation to its wider socio-cultural and political impact becomes evident within the wider heritage discourse.

Yet the taxonomies assigned to objects are not without question, especially within inclusionist Critical Heritage discourses, which argue that the standard and provision of descriptive categories for objects fail to acknowledge the polysemy of objects (Cameron and Robinson 2010). Indeed, digital technologies and information systems can, to some extent, offer a means of promoting democratised practices and the ability to store and receive a vast amount of data: consequently, this negates the need for museum authorities to make authoritative statements about their objects. Yet, the classification of objects is not the only means of

defining them in the museum. The role of the museum curator has come to be a in central and powerful position with respect to the construction of heritage.

2.22 The Curatorial Role

The definition of the role of the curator is more encompassing than ever before. Once seen as keepers of artefacts, today the curator's role includes that of interpreter, commissioner, manager, educator, activist and organiser, to name only a few of his or her functions. Indeed, Martinon's (2013) edited series aims to reveal how 'the curatorial is an embattled term that cannot be singularised or totalised and it is perfectly ok to live and work with such a warring term' (Martinon 2013: 4).

The term 'curator' first came into use during the 14th century as a term for an overseer or a guardian. Furthermore, the root of the word is the Latin verb 'curare' meaning 'to take care of' (George 2016). It is clear that curators today occupy a central role as carers of heritage artefacts, safeguarding not only their physical reality but also their cultural authenticity and authority. Yet this central role has until very recently been overlooked in museological writings and even today it has a relatively sparse history (George 2016). Those who engage with understanding the curatorial (Martinon 2013, Hoare et al. 2016, Smith 2015) argue that at the core of contemporary curating is the notion of bringing people together (Obrist 2011).

The museum's shift from object to audience to community encompasses the amateur collector and his 'cabinet of curiosities', the Enlightenment, during which the museum was a force for social gentrification (Miller 2005) and the establishment of a curatorial discourse in relation to the professional curator (Amundsen and Morland 2015). Contemporary curatorial outputs tend to focus on wider social issues rather than on the individual audience. As MacLeod (2005) argues, the museum is in a constant state of reinvention as it deals with external, financial, environmental, educational and societal forces that shape what a museum should be. Throughout this process of reinvention, the curator has remained semi-invisible. And yet increasing political pressures appear to be making him or her more visible and accountable. The public role of the museum means that while it occupies a position of power, it is also one of accountability driven by the public purse and by expectation.

Just like the object, the curator has come to occupy a central position in the museum and play a central part in the construction of heritage (O'Neill, et al 2016). Yet, despite this, there has

been a continued systematic devaluing of specialist curatorial knowledge. Cuts to cultural funding seem to target specialist knowledge in favour of audience engagement, as is the case for Leicester Museums, where the curatorial teams are being disbanded and replaced with an audience engagement and outreach team (Weaver 2019). Perhaps this is because the work of the curator is occurring behind the scenes and is often compared to audience engagement which rests in the domain of front of house.

In general, museum curation l has always been seen as backstage or behind the scene (Moreira 2013). This is evidenced by museums not citing their curators as authors of their exhibitions. Yet the performance of curation is a deeply processual act in which the intentional and the unintentional take place. While the 'behind the scene' of a show is never meant to be seen, the curatorial process is one that reinterprets our cultural heritage, transforming objects, reinterpreting histories, value and meaning. Joy (2014) argues that the curatorial is a transformational process, which creates an artificial hierarchy of value, which can be based on financial worth, aesthetic judgments or a curatorial assessment of communicative value. This is a point reinforced by Hien (2000), who argues that, without altering their physicality, things undergo a semiological transubstantiation within the museum. In that their meanings change, they morph from one meaningful state to another, in practice an object becoming a 'museum object'. For example, the very act of displaying a 'thing' - the framing of it, the written interpretation, the detachment from its once physical use and its display with associated objects - alters our perception of the object (Henning 2006, Kidd 2014). Our perception of the object has changed. Yet the museum has not altered the physicality of the object in any way.

Barker (1999) extends this point further, noting that there is an artistry in the display evidenced by the double meaning of the term 'installation'. Joy (2014) expands on the importance of object-curator relationships by stating that the accessioning process is the most significant process, as it has the effect of resetting the biography of the object, making it a very different kind of thing as it becomes part of a museum collection. In this sense, the relationship between curator and object serves as a means of re-interpreting and restricting objects within the political and social framework of the museum. As such, the curator is responsible for transforming the object from an 'object' to a 'museum object' where its

classification, interpretation and function within the museum are dependent on the curator's perspective. It is, therefore, imperative that a study should explore how and why curators engage, re-interpret and transform objects through the curatorial process and how 3DSP may change, frustrate, or enrich such a practice.

The existing 3DSP-museum literature has not yet taken into account the role and relationship between object and curator, a potential result of the shift from the object-centred to the audience-centred museum. This move is partly driven by the requirements to quantify spending and to increase visitor numbers, to use what is learnt from visitors to strengthen exhibitions and programmes, and to formulate outreach strategies and improve services (Museum ID 2016). However, while many commend the museum for its new open and inclusive role (Roos-Brown 2013), some argue that the dismantling of intellectual expertise and the dumbing down of audience engagement devalues the museum (Reynolds 2016). However, this view is not a reflection of current museological thinking.

As Miller argues, there is 'a natural dualism between people and things' (2005:76) and nowhere is this more apparent than in the museum. The position of curator is one that bridges 'people', through the proxy of interpretation and audience engagement, and 'object' through research and specialised knowledge. The focus is on the process of curating and the relationship between the curator and the object. Such a relationship is paramount to the museum rhetoric in that curators have the power to interpret objects (Dudley 2010) ultimately affecting how the object is perceived by audiences. Yet the predominant focus of object-curator writings tends to be on the curation of contested objects (see Hamilton 2014), difficult themes (Milton et al. 2011) or the glass case (Hackner 2005), which, as Ames (1992:32) argues, serves as a means of 'sanitising and insulating' objects. The everyday role and relationship between curators and objects seem to have been undervalued or disregarded in the canon of museum and material culture literature, with the transformational relationship between the two having been lost (Balzer 2015, O'Neil and Wilson 2010).

2.3 Replicas in the Museum

The replica has played a key role in the development of the museum from souvenirs (Stewart 1984) to photographs (see Edwards 2009) to casts (Baker 2010) to 3D scans for experimental

archaeological models (Perry 2013). Indeed, Eco (1998) highlights the plethora of reconstructions used by museums to support pedagogical decisions. However, as he mentions, the use of reconstructions is often bound by participatory or visual clues for the visitor that indicate that the object in front of them is a replica. Such is the case in The Museum of The City of New York which houses models of Bethlehem and Wall Street as 'substitutes to reality' (1998:8).

The authenticity of physical replicas has a chequered and ambivalent history (Rabinowitz 2015, Fyfe 2004). Throughout history there have been different types of replicas that occupy different levels of cultural significance or perceived value. For example, The Acropolis's Parthenon casts and the Victoria and Albert Museum's Cast Courts have come to occupy a central and meaningful role within a heritage and museum discourse. Yet the same cannot be said for replicas used in museums handling collections which have been seen as throwaways.

Despite replicas being used in museums by art educators for audience engagement for decades, very little research has been conducted into the role of the replica within the museum and how it is perceived (Foster and Curtis 2016). Of the literature that does exist, the majority tends to focus on archaeological replicas with a historical significance (Foster 2010, Joy 2002, Bearman 2011) rather than on those embedded within museum theory and practice. This is, perhaps, because concepts of authenticity, uniqueness and originality have come to dominate the museum narrative, as is evident in Lathem's (2016) interpretative phenomenological paper which explores the concept of 'the real thing'.

The relationship between the replica and the museum is in constant flux, and not always in a positive way. The concept of 'the original' rose to prominence during the 18th Century (Thiemeyer 2015, Bearman 2011) and with it modernity's effect on the museum in the form of a system of classification (Keene 2016). Hooper- Greenhill (1992) even argues that the ascent of 'the original' became a central fetish of the museum during the 18th century.

The status or perceived value of the replica has developed in line with museological theory and practice. During the mid-nineteenth century, museums were keen to develop an encyclopaedic collection using casts, photographs and replica specimens to fill in gaps (Klonk 2009). Yet Joachimides (2001 cited in Thiemeyer 2015) gives examples of practitioners in the early 20th century removing replicas from the museum in a bid to show only masterpieces.

The changing perception of the replica is deeply tied up in the current debate around authenticity. Foster and Curtis (2016) state that, during the 20th century, art curators were questioning whether the material properties of casts misled the viewer.

Such a concern is still prevalent today. Even the word 'copy' has become associated with negative connotations surrounding mass production and materialism. Wetering (2010: 106) questions how much 'influence does the incessant confrontation with reproductions have on our aesthetic expectations'. The reference to copies as 'incessant', implies that copies not only have the potential to become a prevalent part in the museum but also to have a significant impact on our understanding of objects within the museum. This is a point which is supported by Akker and Legêne (2017), who argue that understanding is a tripartite process dependent on audience - object - context.

However, some authors have come to acknowledge the value of the replica, calling for it to become recognised as an original in its own right (Latour & Lowe, 2011). The passage of time and the potency of the object in its given context allow the audience to experience the object in the same way as the original. Yet it is important to mention that such a concern does not include contemporary replicas or replicas made by mechanical means. Within contemporary museum practice, we appear to have been seduced by the technical capacities of digital technologies so much so that our understanding of the relationship between physical objects and digital reproductions is extremely limited (Classen 2005). This extends to 3DSP in the museum in that the use, reception and loss of the object, both in terms of what is perceived and understood, has become a gap in knowledge. Fahy (1995) ascertains that in order to avoid the seduction of exciting technological developments, we must never lose sight of the fact that in order to communicate, we must have something to say and, to do this, we need to return to the heart and life-blood of the museum, the object and its associated information. As a result, there is a need to address the lack of literature surrounding the replica from an object centred perspective and, to do this, there is a need to situate the replica at the heart of a study.

2.31 The replica vs Authority and Authenticity

The concepts of authenticity and authority have been able to seep into every aspect of museological literature from human remains (Jenkins 2010) to questioning the real (Evrard

and Kerbs 2018) to forming an overarching digital heritage theory (Cameron and Kenderdine 2010). Works by Lathem (2016) and Poulter (2011) prefer to focus on the concept of the real in relation to understanding, as if the term replica is tainted (ICOM 2010). This avoidance of the replica can also be seen through the lens of museum learning (see Jackson 2005) in that there is a desire to establish and structure authentic museum experiences. What this literature suggests is that authenticity and authority is used as a framing device for avoiding the discussion of the qualities and life of the replica, perhaps on the assumption that contemporary replicas cannot be ascribed a sense of authenticity and authority, owing to their lack of a relationship to past cultural events and people.

However, while there is not much literature on 3D printed replica in the museum, there is a canon of research devoted to the digital replica, which includes, but is not limited to, photographs, digitalised illustrations and 3D scanned objects, (Cameron and Kenderdine 2010 and Akker and Legêne 2016), potentially in response to the ever-growing field of digital cultural heritage and museums' obsession with cataloguing, ordering (Pearce 1995) and assigning value (Keene 2006). Yet these curatorial processes also have an effect on how the digital replica is perceived; a point which is supported by Hogsden and Poulter (2012), who argue that 'real' and the digital object are often framed as disconnected and oppositional entities, a separation that hinders approaches to, and uses of, digital forms. Indeed, Bandiera et al. (2013) use the term 'digital surrogates' to describe replicated museum objects.

Witcomb (2007) furthers the above argument by highlighting the main concerns of digitisation and digital replicas. She indicates that it is the loss of aura and institutional authority, the inability to distinguish between the real and reproduction, the death of the object and the reduction of knowledge which generate an affront to the very nature of the museum. Such a statement also applies to the physical contemporary replica, in that the material aspect of an object also forms an important baseline for judgements of authenticity (Knell 2010). Yet, as Benjamin (1970) argues, authenticity is not merely concerned with when an object was made or by whom but with assigning it to a life-world. Benjamin (1970) further argues that the act of mechanical reproduction diminishes an original work by changing its meaning and thus the aura of the original is no longer present. Benjamin's ideas have been revisited by contemporary writers like Boris Groys who argue that the digital (especially online) may produce their own forms of aura.

Yet, such a notion applies to the photograph and raises questions about whether digitally and physically replicating museum objects in 3D would diminish the museum objects' perceived potency in the eyes of curators and audiences.

In the museum, touch is the sense most associated with the exploration of authenticity (Rovine 2010) and our material world (Giachritsis 2008). The practice of touch has been explored within the museum for the past few decades, especially as a means of facilitating reminiscence and memory (Jacques 2007, Noble and Chatterjee 2008, Philips 2008). Furthermore, digital technology is being used to explore tactile interaction. Marshall et al. (2016) use tangible smart replicas to support physical object interaction within the museum exhibition. All of these projects acknowledge the value and museum application of sensory modalities, in that the ocular alone is not enough.

It is therefore surprising that little work has been conducted into authenticity surrounding 3D printing in museums, whose physicality allows for robust interaction. This is not to say that the contemporary replica can be valued in the same way as the museum object, but raises the question whether the printed and scanned object can be seen as an object in its own right. Wilson et al. (2018) do touch upon visitor concerns about the replica being perceived as the original and thus impacting on cultural authority, but fail to relate it back to the physical properties of the object.

2.4 3DSP in the museum

Technology has become a ubiquitous aspect of nearly every field in our modern-day lives (Surrey, D., Baker F. 2016) and the museum is no exception. 3DSP's introduction into the museum sector has permeated multiple areas of museum practice and become a keen topic of discussion (Matello and Rossi 2011), with its applications already extending to repatriation (Cronin 2015), research (McKnight et al. 2015) and audience engagement (Stott 2013, Huerta, D. 2013). Stephens (2013, 2013b) highlights the potential applications of 3D technology with particular reference to the visitor experience, collections' management, education and outreach work. In practice, 3D printing is positioned as a tool within museological literature. Yet 3D scanning on its own tends to dominate current digital heritage literature, especially in relation to developing 3D for virtual heritage environments (Champion 2018), digital archives

(Angeletaki and Carrozzino 2018) and commercial visualisation platforms (SketchFab 2015 and Scan the World n.d.).

2.41 3D printing in the museum

3D printed objects have been accessioned into museum collections, such as the 'Liberator Gun' in the V and A (The V&A, 2015) and 3D scans are regularly used as part of museums' E-collections (The Smithsonian n.d. and Museums Sheffield n.d.). Yet very little is known about how 3DSP affects museum practice and, of the little published research, none addresses the curatorial perspective. This is a concern, as the curator engages with the material object at the moment of acquisition, during documentation and beyond (Dudley 2009: 21) and is, therefore, positioned at the centre of heritage construction.

Apart from the cases explored above and that of Murphy (2013), curators' and participants' perceptions are absent. Murphy draws on a hackathon at The Metropolitan Museum of Art in New York to examine how a 3D printed object 'could be used to engage audiences and assist curators who work with unique and delicate objects', but neglects to state how 3D printing would affect practice and omits curatorial perception. The above workshops and audience engagements are concerned with the singular museum voice presented to the public and not the individual apprehensions of curators or curatorial departments. Articles and reports such as those by Hess and Robson (2013) highlight concerns about training and using the technology effectively. Reports outlining case study processes and outcomes, by Murphy (2013) and Stott (2013) provide specific examples of these museum-3D printing engagements but omit curatorial and audience perceptions. This type of dissemination is not uncommon in the literature surrounding 3DSP in museums; blog posts and reports such as those by Biggs (2014) and Huerta (2013) map the processes of creating 3D printed museum objects.

Articles such as those by Hess and Robson (2013) and Wachowiak and Karas (2009) map out the stages of developing 3DSP objects through the lens of archaeological conservation. Furthermore, Olson, et al. (2014) specifically discuss and examine 3D printed archaeological objects whilst highlighting the stages of 3D scanning and printing. The academic perspective of 3D printing's introduction into the cultural sector clearly shows how the technology is being used to support museum practice, particularly from a conservation standpoint. Yet very little

research has been conducted to assess how curators perceive the impact of 3DSP on their practice, despite their evident involvement with 3DSP technology.

With regard to the museological literature that does address 3DSP printing, Dieck and Jung (2015) attempt to develop a co-creation of value framework for visitor engagements with 3D printing. Furthermore, De Jong (2013) highlights the lack of research undertaken in this emerging area by stressing the potential implications of integrating 3D printing into museum practice. Yet these articles remain theoretical and, in the case of Dieck and Jung, omit first hand research with audiences. Wilson et al. (2016) explicitly evaluate how audiences respond to the integration of 3D printed objects in the museum, presenting an overarching study exploring visitors' responses to 3D printed museum objects, but they fail to question how such objects' materiality affects audiences' perception.

The use of touch has come to define 3DSP's integration into the museum as it breaks down the barriers of 'do not touch' and relates to the calls to access the constructive ideologies that dominate the museum (see Hooper-Greenhill 2007). Practitioners and researchers such as Chatterjee (2008), Paris (2002) and Pye (2008) echo this and call for a return to the use of the senses within the museum. Thus there is a moving away from the ocular centralism that has come to frustrate audiences. (Linsey, Bowen et al 2013, Candlin 2003).

From the perspective of the museum, experimentations with 3DSP predominately take the form of workshops and audience engagements (see Huerta 2013) with the 3D printed objects taking priority and the scans considered as secondary. This is despite recognising the value of the 3D scan, in terms of opening up heritage by sharing objects across global and institutional boundaries. See Sketchfab (2015) for the 300+ museums currently sharing their 3D scanned objects with audiences.

2.42 3D scanning in the museum

3D scanning in museums has become an emerging field of practice among those from technological, engineering (see Bogue 2003) and, to some extent, archaeological backgrounds (see Kuzminsky and Gardiner 2012), perhaps as a consequence of 3D scanning originating from a STEM field. Its complex systems, processes and construction naturally align with functions in these fields, with archaeology using scanning systems for decades to reconstruct and analyse ancient sites. Furthermore, published manuscripts that discuss and utilize 3D

scanning in the museums are typically aimed at specialists in the field of palaeoanthropology, (see Friess 2010). Yet, while this literature reveals the applications and perceived use of 3D scanning in cultural heritage which include, but are no means limited to, digital conservation and restoration (Bandeira et al 2013, Fowles et al. 2003), research (National Museums Liverpool n.d.) and accessibility (Weber et al. 2011), it has remained process based, documenting the methods of this technology. For example, Levoy et al. (2000) present a case for scanning large museum sculptures by the artist Michelangelo, focusing on the laser triangulation scanner, algorithms and software developed for handling very large scanned models.

To my knowledge, there is no literature that deals with audiences' or curators' subjective understanding of 3D scanned museum objects. However, Galeazzi et al. (2015) have conducted a comparative study between 2D pictures and 3D digital replicas. Their results show that 3D digital replicas of artefacts are a more effective means of digitally preserving tangible cultural heritage, as 3D multi-visualization augments the perception of physical characteristics of the artefacts, allowing a more embodied experience with these objects.

A detailed review of available 3D scanning literature reveals a paucity of existing work on 3D scanning in America, a point supported by Wachowiak and Karas (2009), who state that the majority of available literature is provided by commercial companies hired by museums. While such a statement may have changed slightly with the emergence of The Smithsonian's 3DX platform (n.d.), it is clear that European museum researchers and practitioners are at the forefront of 3D scanning. Within the UK, museums such as The Natural History Museum (Burton 2017) and The Victoria and Albert Museum have integrated 3DSP into their science and conservation practices. Furthermore, The British Museum ran a '3D imaging in Cultural Heritage' conference (2017) and The Petrie Museum, in association with University College London, have developed 3DPetrie (2017), a research programme looking into the viability of using high-quality 3D images of museum collections. This technology is also used by university museums and research institutes such as The Cultural Informatics Research Centre (n.d.) at Brighton University, which provides seminal research investigating 3D virtual environments and cultural heritage systems. However, again, the impact on the practices of those involved is never explored.

2.5 Summary

The literature regarding 3DSP in the museum is broader than I had originally thought in its use in specialist museological and archaeological practice, a consequence of its STEM origins. Yet, as mentioned above, this literature has yet to cover how 3DSP is perceived by the museum and its curators. This gap in knowledge has not hindered museums, especially UK nationals, from integrating 3DSP into their practice, yet how the integration of 3DSP into the museum has affected practitioners has yet to be explored.

The relationship between the curator and the object has been acknowledged as a key framing mechanism for interpreting objects within the context of the museum. However, it is currently unclear how curators think 3DSP would impact on their practice. The consequence of this gap in academic and industry-based knowledge could impact negatively on the curators and museums who wish to engage with this technology and develop future 3DSP museum projects. It is, therefore, important to consider a study that takes into account not only the curatorial perspective but also the impact such a technology would have on curatorial practice. Considering 3DSP as a tool for curatorial practice raises questions about the role of the replica, its materiality and objecthood within the confines of the museums framing mechanisms.

As noted in the above contextual review, such questions are not new to the museum environment, with the replica forming a key part of the museum's development. Yet the introduction of 3DSP within the museum provides the opportunity to examine the use of the contemporary replica produced by mechanical means. The rapid replication of museum objects, combined with the ability to change and manipulate 3D scans, is a new form of practice for the museum and a key one for it to explore. Yet the lack of literature that focuses on the use of 3DSP and how it could and does impact on current museological practice, means that questions about replication, authenticity, and even the logistics of managing such objects within the framework of the museum, remain unanswered.

As a result, there is a need to study not only the curatorial perspective of 3DSP in the museum but also to locate it within the politics and the practice of the institution. As mentioned above, the museum does not exist in isolation. It has the power of authority but also a responsibility

to the public and, as a result, there is a relationship between museum curator and audience that needs to be explored.

3. Method

3.1 Introduction

This chapter describes the research process necessitated by the gaps in academic knowledge outlined in the contextual review above. The research is qualitative and draws on curatorial practice in the museum in an attempt to understand how 3DSP affects curatorial museum practice. It explores the methods chosen to obtain detailed accounts from curators who have used and are using 3DSP in their own practice

The chapter first outlines the approach adopted for undertaking this research. It then details the criteria for choosing the museums used in this study. After which, the chapter outlines the three phases of the research: an Acclimatisation Study and two Residencies. Finally, I describe my plan for researching in the museum and the methods of data gathering and analysis adopted.

3.2 Approach

In contemporary museum practice curators have come to occupy a central position in the construction of heritage-based knowledge (O'Neill, et al. 2016), as they have the ability to construct heritage interpretation and narratives in line with their own museum's interpretation strategy. Yet very little research has actually been conducted on the practice of museological curators, with Arts and Heritage researchers preferring to focus instead on curators who are working in contemporary art practice (see O' Neil et al 2016, Martinon 2016, Putman 2016). Yet contemporary artists are keen to turn their gaze on the museum by examining what museums do, see Grayson Perry (2012), Gregory Sholette (2015) and Liam O'Connor (2011).

As such this study took a practice-led approach to researching the impact 3DSP has on curatorial practice in the museum. Practice-led research is an original investigation undertaken in order to gain new knowledge partly by means of practice and the outcomes of that practice (Candy 2006). It is intended as an experiment in order to push boundaries, ask questions, to learn more about our art and our role within it (Skains 2018).

Within the context of the research the practice is the act of curation and the making of 3D scans. I used my practice to examine how and why 3DSP impacts the changing role of the

museum curator. I curated and created exhibitions and objects (see subsections 3.21, 4.43, 4.53 and 4.54) that are designed to provoke new insights and ideas for both myself and the curators I will be working will. As (Mäkelä 2007) argues objects and exhibitions are conceived both as answers and provocations to particular research questions.

Key examples that relate directly to this study include Tim Etchells and Vlatka Horvat '*What Can Be Seen'* (Museums Sheffield 2017) which draws on the city's collections to explore how museums attempt to understand the world through the act of collecting itself. The exhibition brought together disparate objects, photographs of the museum store and newly created work as a way of examining, but also revealing and challenging, the curatorial museum process. The exhibition essentially asks what does the museum process hide?

Elizabeth Price is another artist who has turned her gaze onto the practices of the museum, in particular the archive. Her 2016 video installation '*Restoration'* presented artefacts from the Pitt Rivers Museum's photographic and graphic archives, which were narrated by museum administrators, to imagine how the involuted space of the archive works as a virtual chamber through which museum objects digitally flow, clatter and cascade.

The works listed above highlight how the museum space can also operate as a platform for provocation. It is therefore possible to turn the practices of the museum in on itself, challenging and frustrating traditional forms of practice to reveal sites of tension, enrichment and, potentially, advancement. It has long been known that heritage is constructed, at least in part, from the perspective of the museum curator. As a result, this research will reinterpret curatorial museum practice, transforming everyday curatorial tasks into a way of understanding the world views of the curators I plan to work with. This approach stems from my own practice as a museum curator and a need to examine and understand the changing role of the curator.

As a result, an experimental approach that sought to use 3DSP to conduct research on curatorial experiences and perspectives and, research through curatorial practice has been developed. It was thought that, by using 3DSP within the museum environment, it might be possible to understand not only how 3DSP is perceived by curators but also how current tensions within curatorial practice are emerging as a result of new technologies. It is acknowledged that such an approach is novel and presents considerable risk, including that

of the reinterpreted museum methods not being understood or accepted by curators and the museum not wanting its practices to be investigated.

It is hoped the novel approach of this research could significantly contribute to the identified gaps in knowledge. Firstly, very little research has been done into how 3DSP affects the museum and so this research would contribute to our understanding of this phenomenon. Secondly, experimental research has hardly ever been used to understand the museum, so this research could present a new methodological approach for cultural heritage research. Thirdly, the museological curator is often overlooked when it comes to curatorial writings and, as a result, this research could address current gaps in understanding, consequently supporting the development of curatorial practice across potentially multiple museum sites.

Such an approach is not driven by idealism but is, in fact, deeply embedded within the museum. From my previous curatorial experience, I know that museum curators face an ever-increasing workload which seems to stem from cuts to cultural funding, the systematic devaluing of curatorial expertise (see Weaver 2019) and a growing demand for innovative exhibitions and display often utilising cutting-edge technology. As a result, there was a desire to create methods that did not contribute to or increase the important curatorial work that is already going on.

Figure 2 is an illustration of this research's study design. The research was divided into 3 key stages an Acclimatisation Study and two residencies which were a central aspect to the research. The Acclimatisation Study and Residencies created situations where I was able to examine curatorial experience and perspectives. Within the residencies I devised a series of research tasks, known throughout this study as 'curatorial interventions. These tasks resembled different aspects of the curatorial process and served as a method for me to research curatorial perspectives on 3DSP. Here it is important to mention the 'curatorial inventions' are all strategies for researching curators and their perspectives on curation rather than acts of practical curation in their own right.

Yet as mentioned in the Aims and Objectives (1.21 and 1.22) this research positioned the act of curation and exhibition making as a research strategy. The conjunction with the residencies 3 exhibitions were developed (see practice-based submission pp.56-72, pp.109-122 and

pp.126-141). The curation of these exhibition allowed myself to explore the datasets, research questions and problems in a visual and experimental way.

As mentioned in the definition of terms, the traditional museum has come to encompass multiple sizes, structures and collection themes. As a result, I sought to conduct this research across different museum sites to try and reflect the different styles of museum. The criterion for selecting each museum for this study was location, whether the museum curators were willing to engage in an experimental 3DSP project and finally, and more significantly, whether they had been involved with 3DSP before. It is, therefore, envisioned that a study across different museum sites would not only throw light on the curatorial position on 3DSP but also provide a perspective on how it exists in different museum environments, departments and structures.

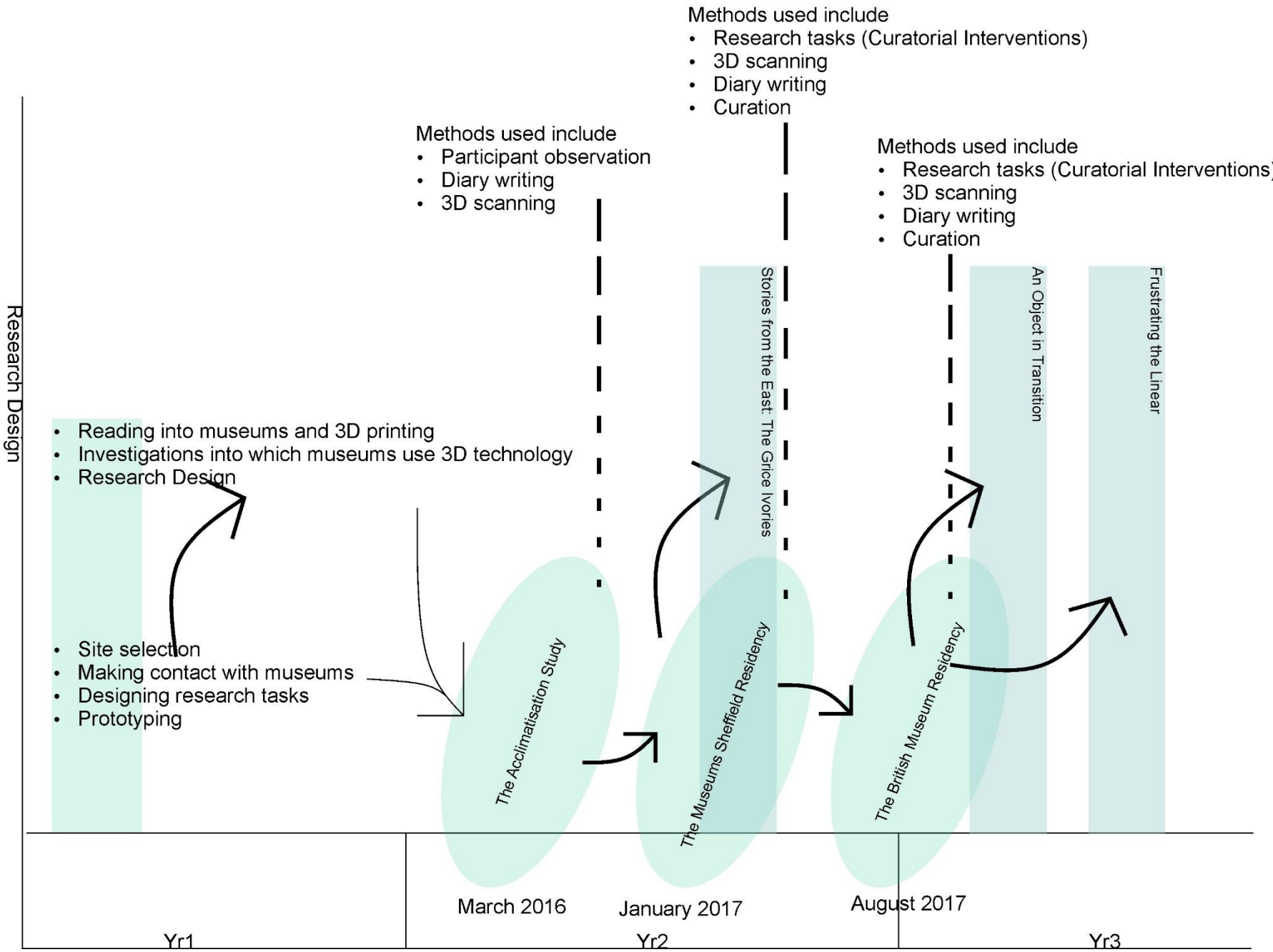


Figure 2 Illustration of this studies research design

There was also a need to review the core collection of the museum, given how some materials, such as glass, are extremely difficult to scan. Working with only physical objects with 3D decoration also limits the number of works chosen from fine art collections. The reasoning behind this is that 3D scanners capture geometry and texture separately, which means that any object 3D printed without its texture would be missing all of its 2D detail.

3.21 Making Exhibitions

The above section illustrates how artists have turned and continue to turn the practices of the museum in on themselves, as a result providing self-reflective opportunities for museum staff to explore and observe their role and what it does to objects. This reflective approach to working in the museum was adopted in this study. I sought to develop a series of exhibitions, one for each phase of the research, that aimed to provoke new insights, regarding 3DSP's impact on curatorial practice, for both myself and the curators with whom I worked.

The value of these exhibitions and the act of developing and curating them lies in how they will help to further my own understanding of the dataset, while allowing curators and audiences to observe, and potentially partake in, an exercise that showed in a visual way how 3DSP affected the role of the curator. The exhibitions were not predesigned. Their form, content and aesthetic were driven by the data collected from each research phase and curated to expand upon key themes within the data.

The curation and installation of the exhibition are considered as a research strategy, making exhibition allowed me to extrapolate data, visualise and explore it in new ways. The processes of layering, transforming and combining images and narratives, from my curators, into a visual format provided new insights into how 3DSP impacts on the curatorial role.

Here, the making of the exhibition just as important to the research process as the actual exhibition (see practice-based submission pp.131-138). It must be acknowledged that the act of designing, making and curating exhibitions is a personal process and harks back to my time as a curator. Using the exhibition process as a method would allow me to spend time with my collected data, examining it from multiple perspectives and developing a deeper insight into how curators perceive 3DSP in the museum.

3.3 Site Selection

Since the selection criteria for the museums and curators taking part in this study included location, core collection and experience with 3DSP, museums from across the UK and abroad were considered and their interest in taking part ascertained. The criteria for selecting the museums were as follows;

3.31 Location

The location of the museum formed a key part of the selection criteria, as regular access to the museum, its curators and collection was necessary. Transporting high-resolution 3D scanners to the museum required ease of travel and minimal distance.

3.32 Core Collection

The museum's collection also had to be considered, to be sure that scanning was possible and appropriate. It was also important to think about the sub collections and curatorial departments which made up the museums core collection in order to have different curatorial responses recorded in the data.

3.33 Experience with 3DSP

Prior knowledge of 3DSP was also important for selecting a museum to work with, as curators would then already have an understanding of the technology and of the challenges and benefits of using it in the museum.

3.34 Willingness to work and contribute to the project

A willingness to work on the project was a key consideration, as although the project did not seek to take curators away from their everyday tasks, it did seek to integrate 3DSP with the practices of the museum and this necessarily required curators to get involved in the processes of 3DSP.

3.4 Choosing the Museums for This Study

The process for selecting museums involved shortlisting a number of museums which had already engaged in 3DSP, researching their collection and approaching the head of the museum with a research proposal. The list of shortlisted museums under consideration for this project were as follows;

- The British Museum
- English Heritage
- The Smithsonian
- Museums Sheffield
- Derby Museums

By the end of the selection process, The British Museum and Museums Sheffield were selected to investigate 3DSP, this was undertaken by conducting a series of residencies. The residency is a key strategy of research in this study and is explored in more depth later in the chapter (see sections 3.5 and 3.54).

Both museums had a willingness to explore 3DSP within their developing 3DSP programme, though it should be acknowledged the scale of The British Museum's programme was greater than that of Museums Sheffield's offering.

It was considered that the combination of these two museums would provide an understanding of how 3DSP works in different museum environments. The two museums have different characteristics, policies and staffing structure that I was able to focus on. For example, Museums Sheffield lacks a dedicated digital team, giving rise to the 'D.I.Y curator' when it comes to anything digital. This is a complete contrast to The British Museum which houses the departments of 'Information Services' and 'Digital Humanities'. The differences between the two museums, including their size, reputation, collections, infrastructure and history not only contributed to how 3D is perceived with in the museum, but also provided different museum ecosystems to research in.

While the two museums could be united though their developing 3DSP offerings, by choosing such sites and omitting the likes to The Smithsonian, this research lost the opportunity to gain an international perspective. Furthermore it must be acknowledged that, while we will be able to know how and why 3DSP affects the regional and national museum, the independent museum is omitted. This leaves us with the question of how the 'do it yourself' curator would respond to this new technological phenomenon. 3DSP is still relatively new and costly, and the opportunities for the D.I.Y curator to engage with this technology would be limited and, therefore, potentially hinder the development of this research. However, it is here acknowledged that this is outside the scope of the study.

The purpose of the two institutions was to try and generate a perspective that takes into account the differences and similarities between them. The British Museum and Museums Sheffield have both published articles on 3D scanning and printing (The British Museum 2013, JISC 2014). Furthermore, Museums Sheffield was ideally located as hosts of the residency and they were also keen to explore the use of 3DSP despite a negative experience from the JISC (2014) project. The museum had an up-coming ivory exhibition and there was a mutual desire between myself and the museum to collaborate on an exhibition. This was considered an excellent and timely opportunity to explore the role of 3DP artefacts in a 'live' exhibition context.

Yet curators at Museums Sheffield had not practically engaged with the 3DSP and were only aware of the technology through the JISC project. As such, there was the need to establish an initial study, prior to the main body of research, that sought to introduce the technology to the practices of Museums Sheffield and its curators.

In contrast, The British Museum had already used and experimented with 3DSP and since it operates on an international stage, comparable in reputation to institutions like The Louvre and The Smithsonian, its use of 3D printing can be seen in itself as an endorsement of the technology within the museum world. The British Museum's research policy includes the creative exploration of the making, use, loss and reception of objects, as well as how these objects and their histories can be effectively presented, exhibited and explored through different media and forms of public learning. By working with multiple collections and curators at The British Museum, the research could explore not only the creation, perception and use of 3D scanning and printing, but situate it within the values of the museum, potentially raising questions about the technology's implementation and perceived value within the museum sector.

Curators from both museums were given a participant information sheet which described my presence in the museum and the tasks that I would like them to participate in. The participant information sheet was adapted to explain fully the desired outcomes and tasks I had designed for each museum (see appendix A1, B1 and C1). The participant information sheet was accompanied by a consent form (see Appendix A2, B2 and C2). It gave curators the right to anonymise their names and the institution they worked for if they wished. It also documented

how their contributions would be used and stored in compliance with the university's ethical standards.

3.5 Researching in the Museum

3.51 Phase One – Acclimatisation Study

The 'Acclimatisation Study' at Museums Sheffield was conducted as an initial means of investigation. This preliminary study was intended to enable me to familiarise myself with the museums and for the curators at Museums Sheffield to do so with the technologies involved in 3DSP.

I first entered Museums Sheffield's off-site store in March 2016 as a volunteer. I was initially motivated to work with Museums Sheffield after reading the report published by JISC (2014), which detailed a 3D scanning project undertaken by researchers at Sheffield Hallam University with the museum's 19th century metal boxes. My initial aim, prior to entering the museum, was to understand how this project had affected curators' practice, as outlined in the Acclimatisation Study's Participant Information Sheet and Informed Consent (See Appendix A1 and A2). Upon meeting with curators, I soon realised that the JISC project had not been an entirely positive experience for the museum, with researchers wanting to get all the boxes out of storage at the same time. As a result, I became interested in how 3DSP could work better within the museum's practice and policies.

From the start of my 'Acclimatisation Study' with Museums Sheffield I focused on introducing 3DSP to curators, who observed, questioned the technology and took part in the 3D scanning. The 3D scanning process was introduced not only as a tool for observation but also as a means of study. Museum objects were selected for 3D scanning by curators and their reactions to the scanning process and their comments were documented in a diary (see practice-based submission, pp.7-8, pp.11-12 and pp.19-20). This process was repeated with curators across Museums Sheffield with comments, discussions and questions also being noted in the diary.

It is important to mention that I worked only with museum staff who had a direct responsibility to a collection. Throughout this research, the terms 'museum professional' and 'curator' are intermingled and used to mean a person who is working within a museum with a direct responsibility for a collection. Increasing funding cuts to the cultural sector means

that many roles are being integrated with pre-existing jobs. As such, a curator can now be defined as anyone from a 'Keeper of Collections' to a 'Site Manager'.

3.52 Data Collections Methods

I aimed to spend 2 days a week with the museum, the time scheduled being wholly dependent on the availability of the curator who would be working with me. During this time scanning techniques, including, Blue Light scanning (Artec Spider) and photogrammetry, were used in situ. Observations and notes about the museum's day to day activities, environment (off-store site) and curatorial roles were recorded in an attempt to understand the organisational culture of the museum. Drawings, photographs and images were also added to this diary in attempt to understand the environment and practice of the curators (see practice-based submission pp.19-20, pp.25-26 and pp.29-30). During this time, completed and unfinished scans were fed back to curators in order to ascertain their perception of 3DSP objects with regard to the making, use, loss and reception of such objects. Their comments were written in the diary and used not only to understand further how and why 3DSP affects the museum, but also to record the progress of the project.

3.53 Data Analysis

After finishing the 'Acclimatisation Study' with Museums Sheffield, I used a thematic approach to analyse and present the data. Such a method is used to find patterns within a given data set. Braun and Clarke (2006) argue for thematic analysis to be seen as a foundational method for qualitative analysis transcending analytical and methodological boundaries. It is perhaps for this reason that Boyatzis (1998) classifies it as not a specific method, but as a tool to use across different methods.

I collated the data I had collected from the 'Acclimatisation Study' and synthesised it into a table. This allowed me to discover themes and patterns in the data. This gives the analysis an inductive approach in that data analysis is guided by the evaluation objectives, which identify the domains and topics to be investigated. As Thomas (2006) argues, analysis should be carried out through multiple readings and interpretations of the raw data.

An open coding approach was adopted to allow for key ideas and themes to be pulled out of the data set (Silverman 2017). Such a method resulted in a set of codes/themes that were not

initially relevant but provided an over view of the data and showed how 3DSP was generally perceived by curators. Careful re-reading of diary entries enabled broad categories and key ideas to emerge. This material was brought together with other data generated by the curators, such as 3D scans, allowing links and relationships to be identified.

3.54 Phase Two and Three. – The Residencies

The term residency can be found in a wide range of practices and fields and within each of these areas a definition of the term will vary (Bletcher et.al 2013). However, in the context of this research, the residency is considered in the setting of the museum and gallery. Increasingly museums are working more collaboratively with other industries and examining the benefits of interdisciplinary exchange of resources (Kendall 2011, Bishop 2004). In today's cultural environment, this can be seen in the creation of 'Makerspaces' in museums and galleries across the UK (see Craft Council 2018).

As mentioned above the residency was used a key research tool. Within the context of this thesis it was used as a means of both creating situations in which to research in and providing a way of developing a repour with my participants. The value of the residency is that it offers a creative professional the time and the resources to develop levels of creative explorative practices (Bletcher et.al. 2013). Within the context of this research, opportunities to work with curatorial teams across the museum, on all manner of their activities, were sought. This included documenting, exhibiting, and researching objects as well as contributing to current external projects. It was envisioned that both residencies would contribute to a creative output that supported and related to the museums current curatorial production.

During each residency, a series of interventions was developed that drew on the curatorial processes. Details of these were given in the participant information and informed consent sheet (See Appendix B1, B2, C1 and C2) for both the Museum Sheffield Residency and that of The British Museum. For the purpose of this research the term interventions follows the definition outlined by Marstine (2017:4), that being an intervention from a museological perspective is an artistic strategy that encourages self-reflective museum practice. These curatorial interventions were designed as a method of researching and gathering curatorial perceptions and as such were a research task and not an act of curation. The curatorial interventions were designed to be as accessible and user-friendly as possible, and to allow

the widest set of responses. They were then evaluated and fed back to the corresponding curators.

The presentation and design of the curatorial interventions (research tasks) arose as a consequence of the fact that I planned to work with lots of different curators over a short period of time. This method and presentation allowed me to focus on spending time with participating curators, understand their practice, and 3D scan objects. Curators were free to complete the interventions in their own time or as the projects developed. It was envisioned that such a method would offer a new way of thinking about 3D digitisation. Influenced by museological curators' daily responsibilities, the curatorial interventions had the potential to reveal new systems of hierarchical value, knowledge transformations and new ways of considering control and access.

Throughout both residencies, 3D scanning was both the process and subject of the inquiry. The process helps us to see the original artefacts in new ways, while the act of scanning in the museum enables us to see how 3DSP sits within museum practice. I involved the curators I was working with in the processes of 3DSP in an attempt to understand how they perceived 3DSP within their museum and practice.

The results from the curatorial interventions were used to design exhibitions which helped further the research and prompt new avenues of questioning. The exhibitions were held at the end of each residency and drew on the curatorial interventions, observational methods and 3D scans and prints to help visualise how 3DSP does, and could, impact on museum practice from the perspective of the curator. The exact nature and presentation of the exhibition depended on the outcomes of the curatorial interventions as these tasks prompted curators to reflect on or describe their curatorial practice and as such, the results from each curator where incredibly subjective.

3.55 Data Analysis

The analysis of the Museums Sheffield and The British Museum residency used a mixture of analytic techniques. The museum interventions, from both museums, were analysed using thematic analysis and looked for key themes which aimed to ascertain cultural, social, political and curatorial motivations of how and why 3D printing is perceived in museums. As before, there were no pre-conceived codes. I used open reading to gain a familiarity with the text,

images and drawings and let codes naturally emerge. Where there was visual data- maps, drawings and photographs, it was especially important to give time to reflecting on these, as the way they communicate is spatial and textural rather than literary.

The analysis of the curatorial interventions was combined with 3D scans and prints to form a detailed understanding of the impact of 3D scanning and printing on curatorial practice. Thematic analysis is a method for identifying, analysing, and reporting patterns within data (Braun and Clarke 2006). One of the key advantages to thematic analysis is its flexibility, allowing it to be applied across the breadth of the curatorial interventions and 3D data sets.

The analysis of the data took place after each of the residencies had finished. The reasoning behind this was to allow myself the time and space to reflect upon the data and this could only happen once the residency had been completed. However, the nature of the research being conducted at Museums Sheffield and The British Museum meant that some projects existed beyond the confines of the residency. Projects that involved creating 3D work for exhibitions and overseas museums continued to feed data, evidence and new museum narratives to me and are included in the findings of this research.

3.6 Summary

This chapter has outlined the methods and approach used for undertaking this research. It has made a case for an experimental approach; one where traditional social science methods alone are not enough and presented the reasonings and the rationale for undertaking this research. I have outlined why I have chosen to work with Museums Sheffield and The British Museum and listed the criteria for selecting these museums.

I have used this chapter to document my methods and approaches for researching in the museum. The chapter also explains my data analysis plan and the ethical considerations for undertaking this research. An analysis of the data is presented below in The Three Studies: Initial Findings Chapter.

4. Research Strategies and Data Reflections

4.1 Introduction

This chapter sets out the research strategies used and the collected data for this study, as well as how the data was used in an attempt to answer the research questions in Ch.1 'The Introduction'. Within this chapter, I outline each strategy and give a detailed account of each research processes, including their function and purpose. The aim is to give the reader an overview of the methods used and data collected, given the novel approach of this research.

The chapter first identifies the strategies of diary writing, 3D scanning, and making, before setting out the design of each of the three research phases and how the methods listed above were used. Within these sections are reflections on the data collection and an outline of the exhibitions curated from the datasets.

Throughout, images of the data will be used to illustrate how I documented my presence in the museum and how curators responded to 3DSP. A more extensive visual record is supplied within the practical submission.

4.2 Research Strategies

The research strategies elaborated upon in this chapter drew on methods from a range of different fields. I was inspired to employ multiple methods and strategies as I felt it was important to live in the space I was researching in, as well as use curatorial tasks as a way of speaking the language of my participants. The immersion of being in the museum (residency) and augmentation of curatorial activities (research tasks) meant I was able to develop a research design that allowed me to get in-between the curator and the institution. It is here that my position as an insider must be acknowledged; as a former curator, with knowledge of current museological practice I was able to become part of the museum environment. I was given staff cards and access codes and allowed to wander the museum freely. Such a privilege combined with the methods chosen to undertake this research meant I become insider within the museum. This could not have been achieved through traditional social methods such as interviews and questionnaires. It is my belief that this research needed to be done by living in the world of museum curators.

It is here that I must mention that this research's focus on the lived experience of curators does not make it ethnographic. Parts of the method (observing curators and keeping a

research diary) are inspired by ethnography, but the study is not written as an ethnographic piece of work and the practice elements of the research make it decidedly different. The value of ethnography is that is it allows stories to occur within their natural environment (LeCompte and Schensul 1999) and by immersing myself in the museum I was able to experience and capture curatorial narratives around 3DSP as the happened.

4.21 Diary Writing

Throughout The Acclimatisation Study and the Residencies at Museums Sheffield and The British Museum, I sought to immerse myself in the work of each institution. The aim was to understand the practices and the daily working life of the curators and to be inspired by the museum environment. I worked closely with curators, helped them to complete daily tasks, had conversations about 3DSP, I taught them how to 3D scan objects and discussed the changes taking place in the curatorial role. I spent time wandering through both museums' stores and got lost at The British Museum. I observed thousands of objects in endless display cases and pondered over what they all meant. I documented this whole process in a research diary.

I was initially using the diary in The Acclimatisation Study as a way of documenting conversations and observations. I sketched scenes and abstract concepts; I wrote my thoughts down and noted ideas for future research at the museum. As a result, the diary contained curatorial conversations, photographs and reflections on working with technology in the museum (see practice-based submission p.37, p.45 and pp.57-58). However, the nature of the diary changed during the data collection phase of this research, as The Acclimatisation Study progressed, the diary became an instrument for me to reflect upon past observations and conversations. I began to use it as tool to muse upon ideas, I posed questions to myself and explored them through drawings, notes and extracts from academic texts. In essence it became a visual and written scrapbook of my experiences, observations and ideas. Here it is important to mention the diary was a personal method of data and not shared with anyone else.

As the research developed so did my approach to the diary, at Museums Sheffield and The British Museum I used the diary as a tool for reflection. I found myself going back to previous pages to see if there was anything I had missed or if past questions could be answered. For The British Museum Residency I added a dedicated sketching space to help me visualise the

questions I had during my time at the museum. The purpose of this was to visualise abstract concept or hard to articulate conversations. I drew mind maps, conversations and general ideas about the movement and perception of 3DSP in the museum.

The musings and questions contained within the diaries were not meant to be answered, but used to prompt new ideas and thought processes. The lack of an answer served as a reminder, through the constant re-reading of the diary, that the curatorial perception of 3DSP could change. As such, the writings and sketches contained within the diaries should not be treated as linear but as a record of my own thought processes which changed, challenged previous ideas and mused upon conversations. The diary and the act of immersing myself in the museum allowed me to gain insights into the working practices of curators from across curatorial departments. I developed an understanding of how different departments approached object documentation, interpretation and display. These were aspects of curatorial knowledge which I lacked as previously I had only worked with decorative arts collection. The images below represent examples of my diary writings from The Acclimatisation Study and the Museums Sheffield and British Museum Residencies.

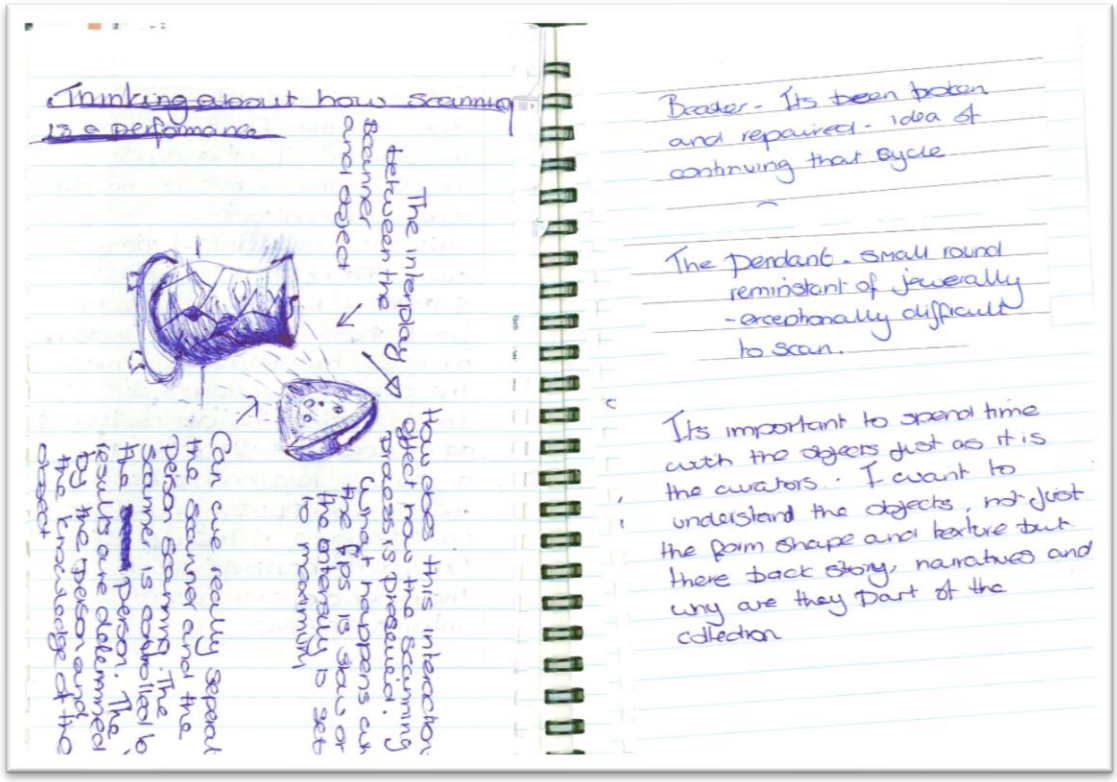


Figure 3 An example diary page from the Acclimatisation Study

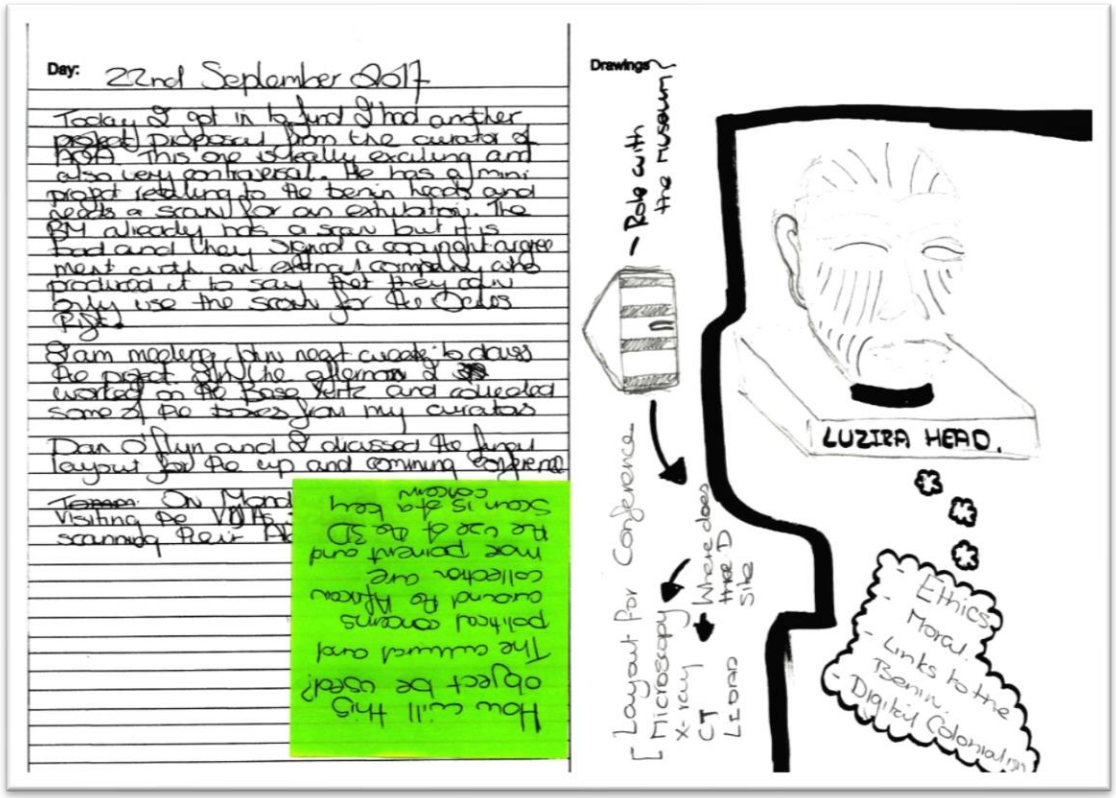


Figure 4 An example diary page from The British Museum Residency

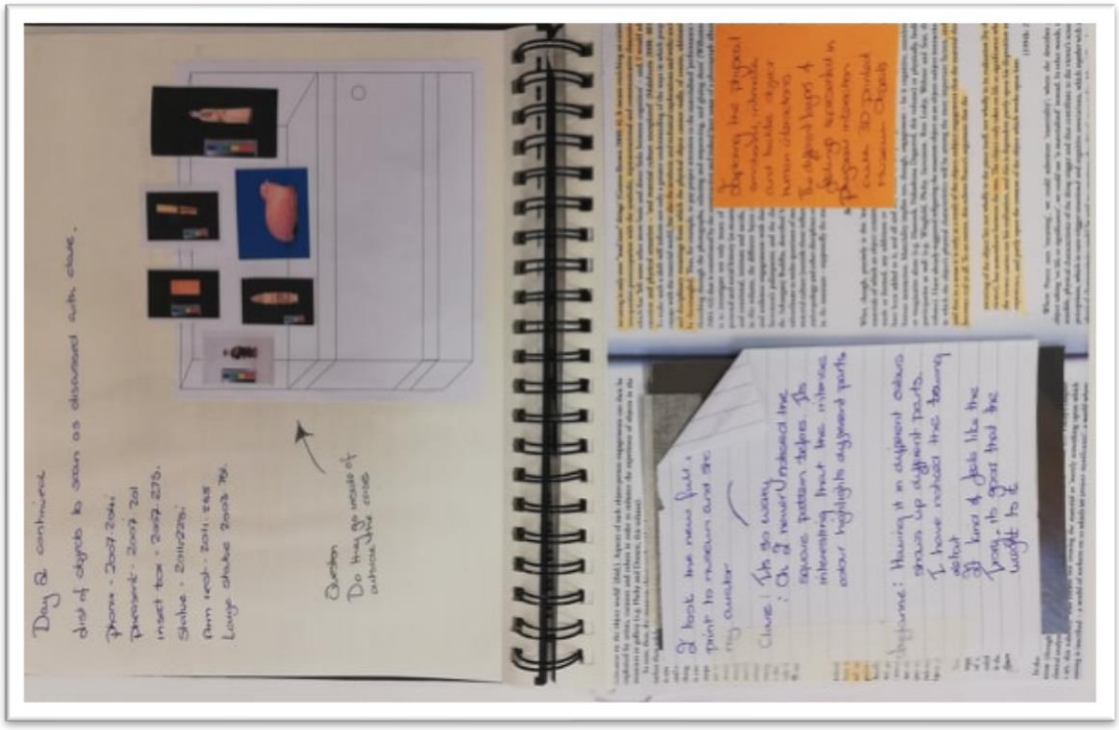


Figure 5 An example diary page from the Museums Sheffield Residency

The example diary pages show just how I reflected upon my experiences and knowledge of working in the museum. In The Acclimatisation Study diary (figure 3), I question what happens between the 3D scanner and the object; my sketching and writing serves as a written and visual representation of the spaces, processes and challenges created when 3D scanning is used in the museum. Such questioning was continued during the two museum residencies; the example page from the Museums Sheffield Residency (figure 5) shows how I draw upon museum literature to review my experience of working with objects. I continued using drawing and writing as methods of documenting my experiences while at The British Museum. The example diary page from The British Museum Residency (figure 4) shows how I wrote, drew and reflected upon the current real-world projects being investigated at that museum.

4.22 3D Scanning

Immersing myself in the museum meant that I was able to 3D scan a whole range of objects that represented the breadth of the two museums' collections. 3D scanning with curators was used as a research strategy in order to capture not only what objects they wanted to scan

but also how their perception of the object and technology changed when they were exposed to the processes of 3D scanning.

The 3D scanning of objects took place in the museums store with both curators and other curious members of staff present. Throughout The Acclimatisation Study and Residencies, 3D scanning was used as a means of provoking curatorial reaction, as well as investigating how the technology impacts upon curatorial practice. Completed scans, whether successful or not were fed back to curators. The act of allowing curators to review the scans meant I was able to generate insights into how different object characteristics such as, file size, colour accuracy, scale and overall accuracy impacted on the curatorial perception.

Museum objects were 3D scanned for a number of reasons, including curatorial curiosity, and do not equally represent the same value within this study. Table 1 is a complete list of all the 3D scans produced for this research.

Table 1 List of Completed 3D scans

Scanned Object	Museum of Origin	Research Phase	Successful Scan
Bronze-Age Burial Pot	Museums Sheffield	Acclimatisation Study	Yes
Small Bronze-age Pot	Museums Sheffield	Acclimatisation Study	Yes
Woven basket	Museums Sheffield	Acclimatisation Study	Yes
Small textured basket	Museums Sheffield	Acclimatisation Study	Yes
Antler	Museums Sheffield	Acclimatisation Study	Yes
Moa Bone	Museums Sheffield	Acclimatisation Study	Yes
Humming Bird	Museums Sheffield	Acclimatisation Study	No
Ivory Vase	Museums Sheffield	Acclimatisation Study	Yes
Blue John Vase	Museums Sheffield	Acclimatisation Study	No
Shell	Museums Sheffield	Acclimatisation Study	No
Marble Bust	Museums Sheffield	Acclimatisation Study	No
Silver Jug	Museums Sheffield	Acclimatisation Study	No
Cloud Glass Plate	Museums Sheffield	Acclimatisation Study	No
Bronze-Age Pendant	Museums Sheffield	Acclimatisation Study	No

Bronze-Age Dagger	Museums Sheffield	Acclimatisation Study	Yes
Egyptian Statue	Museums Sheffield	Acclimatisation Study	Yes
Egyptian scarab	Museums Sheffield	Acclimatisation Study	No
Iron- age Flint	Museums Sheffield	Acclimatisation Study	Yes
19th Century Bust	Museums Sheffield	Acclimatisation Study	No
Stone Bust	Museums Sheffield	Acclimatisation Study	Yes
Silver tea rack	Museums Sheffield	Acclimatisation Study	No
Decorative Glass Vase	Museums Sheffield	Acclimatisation Study	No
Decorative Glass Bowl	Museums Sheffield	Acclimatisation Study	No
Quartz	Museums Sheffield	Acclimatisation Study	Yes
Ivory Arm Rest	Museums Sheffield	Museums Sheffield Residency	Yes
Ivory Buddha	Museums Sheffield	Museums Sheffield Residency	Yes
Ivory Oval Box	Museums Sheffield	Museums Sheffield Residency	Yes
Ivory Rectangle Box	Museums Sheffield	Museums Sheffield Residency	No
Ivory Goddess Statue	Museums Sheffield	Museums Sheffield Residency	Yes
Ivory Mother and Child	Museums Sheffield	Museums Sheffield Residency	Yes
Ivory Pheasant	Museums Sheffield	Museums Sheffield Residency	Yes
Ivory Weather God	Museums Sheffield	Museums Sheffield Residency	Yes
Buddha Statue	Museums Sheffield	Museums Sheffield Residency	Yes
Ivory Plaque	Museums Sheffield	Museums Sheffield Residency	Yes

Phoenix Statue	Museums Sheffield	Museums Sheffield Residency	Yes
Mould Gold Cape	The British Museum	The British Museum Residency	No
Ringlemere Cup	The British Museum	The British Museum Residency	Yes
Gayer-Anderson Cat	The British Museum	The British Museum Residency	Yes
Votive Offering	The British Museum	The British Museum Residency	Yes
Basse-Yurtz Flagons	The British Museum	The British Museum Residency	Yes
Annunciation Alabaster	The British Museum	The British Museum Residency	Yes
Coronation Alabaster	Victoria and Albert Museum	The British Museum Residency	Yes
Last Supper Alabaster	Victoria and Albert Museum	The British Museum Residency	Yes
St John Alabaster	Victoria and Albert Museum	The British Museum Residency	Yes
Ascension Alabaster	Victoria and Albert Museum	The British Museum Residency	Yes
Nereid Frieze	The British Museum	The British Museum Residency	Yes
Eagle Ryton	The British Museum	The British Museum Residency	Yes
Mummy Mask	The British Museum	The British Museum Residency	Yes
The Luzira Head	The British Museum	The British Museum Residency	Yes

The Cornell Cael Bell	The British Museum	The British Museum Residency	Yes
Parthenon Frieze XXXVII	The British Museum	The British Museum Residency	Yes
Parthenon Frieze XXXVI	The British Museum	The British Museum Residency	Yes
Parthenon Frieze XXVI	The British Museum	The British Museum Residency	Yes
Parthenon Frieze XXIV	The British Museum	The British Museum Residency	Yes
Carian Stela	The British Museum	The British Museum Residency	Yes
Horus Statue	The British Museum	The British Museum Residency	Yes
Gold Cuff	Port of Antiquities	The British Museum Residency	Yes
The Blacs Ewers 1	The British Museum	The British Museum Residency	Yes
The Blacs Ewers 2	The British Museum	The British Museum Residency	Yes
Gold Coin	The British Museum	The British Museum Residency	No

All 3D scanned objects, including those which did not scan correctly, are considered as data, as their creation provided curators with the opportunity to observe, challenge and create new forms of curatorial practice. The scan data is a mixture of Artec scans, photogrammetry and other 3D scanning tools such as a 3D Sense and Microsoft Kinect. However, as the Artec Spider produced the best results, it became the main scanning tool for all three research phases. The scan data, whether accurate or not, provided curators with the means to discuss loss, authenticity, practice, form, and relationship between the museum object and its 3D scanned and printed counterpart. Furthermore, using 3D scanning as a method and exposing curators

to the processes of the technology allowed me to observe real-world conversations, which were documented in the research diaries.

4.23 Making

Throughout The Acclimatisation Study and two residency this study used the concept of making as a research strategy. Here it is important to mention the term 'making' includes the curation of the exhibitions and the prototyping of the research tasks (curatorial interventions) used in the two residencies.

Making the exhibitions and curatorial interventions allowed me to explore data and research questions in a creative and reflective manner. I was able to draw upon my diaries and past observations to create exhibitions and research tasks that exposed and questioned sites of tension between the individual and institution.

For example, the research tasks (curatorial interventions) which were used in the Museums Sheffield and British Museum Residency were created by reviewing data from the previous study and drawing on curatorial tasks. This process was an iterative one, creating and testing different designs and concepts. The act of making the research tasks helped to not only understand the research I was developing on but also gain a greater understanding of the data from the previous residency or study. A detailed account for the development of the exhibitions is provided in sections 4.43, 4.53 and 4.54.

4.3 The Acclimatisation Study

4.31 What is the Dataset

The data for the Acclimatisation Study consisted of a diary, written by myself and a selection of 3D scanned objects that represented the breadth of the museums' decorative, natural science and social history collections (see Table 1). The objects selected for 3D scanning were chosen by Museums Sheffield curators.

The diary includes a study of how curators engaged with 3DSP and their perceptions of the technology used within the museum. Observations, drawings and images were made as curators went about their daily activities. In order to facilitate such a study, 3D scanning was used as a context for exploration. Here, it is important to mention, there was a conscious

decision not to work with the museum's fine art collections, as 2D details are lost in the 3D printing process.

In total, 24 objects were 3D scanned during the Acclimatisation Study (see Table 1). The majority of these either produced poor quality scans or did not produce any new insights, nor could they be combined with the museum's current exhibition plans. As a result, the objects used for the Acclimatisation study were continually under a process of revision and re-selection. Initially, curators were sent a guide, developed by myself, that gave suggestions on the type of objects and properties that were easy or difficult to scan. Curators at Museums Sheffield used this guide to propose objects from their own collection. These were scanned and the results fed back to curators, whereupon more objects were 3D scanned and thus the process was repeated. The scans that were dismissed from the project were done so either because they represented objects isolated from the core collection, or because the original object was so hard to scan that the processed scan was unrecognisable as an object.

4.32 The Acclimatisation Study: Initial Reflections

The data also showed the progression of the project, from the first curatorial interaction with 3DSP, to curators questioning the uses and possibilities of the technology and their understanding of what material can be successfully scanned.

The data comes directly from engaging curators with the processes of 3D scanning. The initial responses to 3D scanning were neither positive nor negative; they existed in the realm of apprehension, perhaps caused by the novelty of the technology, or perhaps as a result of prior experiences with 3D digital projects. The combination of 3D scans, recorded curatorial observations and comments in the research diary show how the curatorial perception of 3DSP changed as exposure to and knowledge of the technology increased.

The data shows how curators sought to understand what 3DSP could and does do to museum objects and potentially reveals the internal debate, which the curators at Museums Sheffield had, about the integration of 3DSP. Embedded within this data set are questions about the very existence of physical replicas in relation to museum objects and debates around the changing role of the curator, especially with regard to the ever-expanding realm of digital heritage and technology (see practice-based submission p.9 and p.30). There are also concerns and frustrations about where 3DSP objects sit within the museum and how they can

be curated within the structures of the museum's systems (see practice-based submission p.26).

Embedded in the data themes are concerns not only about what the 3DSP does to curatorial practice, but also about the advisability of replicating museums objects. These concerns are especially prevalent given the fact that curatorial practice is not based purely in objecthood but is a deeply processual act in which hierarchal structures, nepotistic decisions and object relationships all play a key part. The data suggests that 3DSP potentially sits outside of these museological frameworks, possibly causing concerns around how such objects would be documented, recorded and curated in relation to the core collection both online and in the gallery.

Watching curators become involved in the 3D scanning process raised unexpected questions about 3DSP's impact on the role of the museum curator whose job, as discussed in Ch.1 'The Introduction', is continually under review and re-evaluation. These new questions and avenues in research helped to establish the direction of the second study, 'The Museum Sheffield Residency', by identifying a gap in knowledge; the changing role of the curator and of curatorial perception with regard to the acceptance of 3DSP as an integral part of the museum. 'The Museum Sheffield Residency' thus sought to investigate 3DSP in the museum though the lens of the curator, with regard to practice and methods.

4.4 The Museums Sheffield Residency

4.41 What is the Dataset

The data from The Museums Sheffield consists of a series of curatorial interventions and a co-curated exhibition using the museums Ivory collection. The term curatorial intervention is inspired by Marstine's (2017) definition of the term 'intervention' as discussed in Ch.3 'Method'. For this research, the term is used to mean a series of tasks inspired by curatorial methods and practice. Each participating curator was asked to complete these interventions in relation to their own collection, with the aim of simultaneously revealing the curatorial process and showing how 3DSP affects curatorial practice.

Each participant was asked to complete these curatorial interventions (see figure 6) which were inspired by the curatorial processes of accessioning, documenting and displaying museum objects. The interventions, completed by Clare, the Curator of Decorative Arts, formed the basis for the ivory exhibition which provided an example of how interventions can be used in actual museum practice. The curatorial interventions were informed by 3D scans and prints from the curator's collections and provided real-world examples of how 3DSP impacts on the curatorial perception and practice.

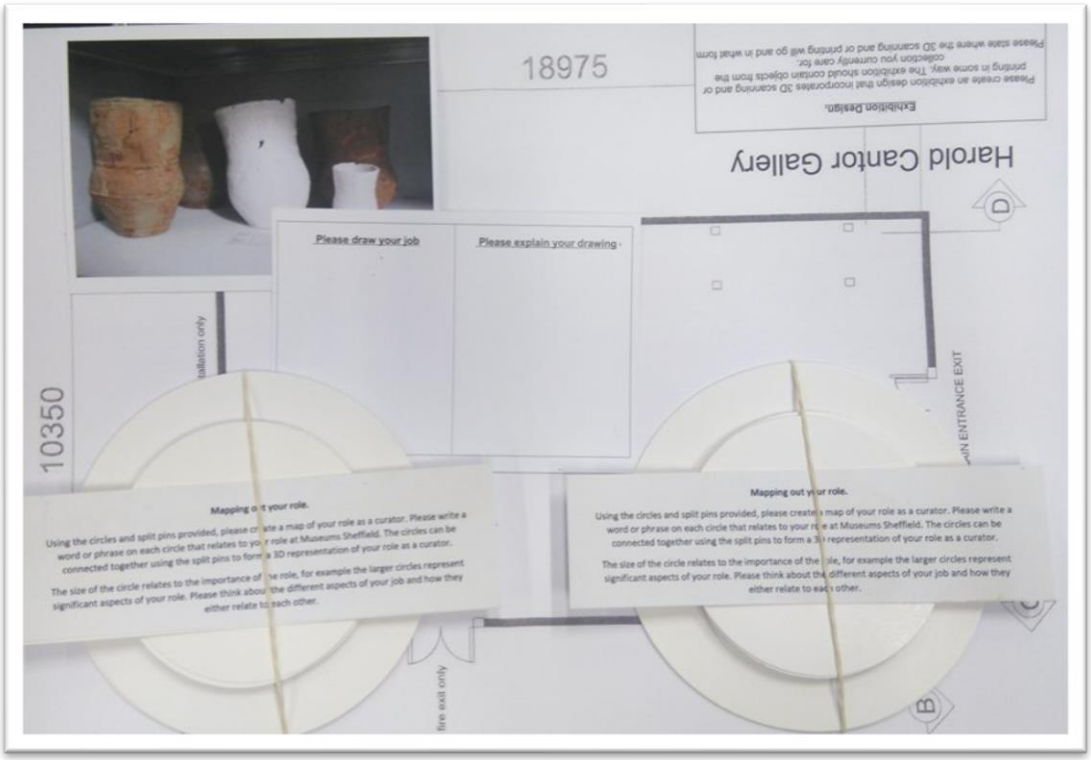


Figure 6 Image of the Museums Sheffield Curatorial Interventions

The resulting data was a collection of 3D scans from the museum's Ivory collections and from curatorial interventions from curators working with Archaeology, Decorative Arts and Social History collections. Below is an outline of the data collected from the Museums Sheffield residency:

- A completed accession form for a 3D printed object from the curator's collection*
- An in-case museum label for the accessioned 3DSP object written by the curator
- Completed 3D scans and 3D printed objects
- Observations and photographs, made by myself, when engaging curators with the 3DSP process

- An exhibition concept that contained 3DSP and objects from the curator's collection

**The objects were accessioned using my version of Modes, as the 3D scans/objects might not have complied with the museum's collecting policy. Using my own software meant that the 3D scans/ objects would not appear on the museums database.*

The exhibition concept or theme were left to the curator's and could have included any part of their collection; the only requirement was that the exhibition had to include 3DSP. The exhibition concept reinterpreted curatorial practice of designing and laying out an exhibition concept (as shown on pp.36-37 of the practice-based submission) and showcased how curators perceived the use of 3DSP within the gallery context, as well as revealing their knowledge and use of 3D scanning and printing.

4.42 The Museums Sheffield Residency: Initial Reflections

The data from the Museums Sheffield Residency showed how curators would curate 3DSP objects, as well as revealing their concerns about how far 3DSP should be an integral part of museum practice. There were concerns and frustrations about accessioning 3DSP objects into the museum collection. Yet, at the same time, the exhibition concepts, outlined in full in the practice-based submission (see pp.50-54), showcased how curators used 3DSP to support access and engagement through interactive exhibits, enlarged displays, handling objects and digital interpretive panels.

By visualising how 3DSP objects could be curated through drawing, maps and object analysis, the perceptions and attitudes of curators were captured, revealing not only the perception of 3DSP but also insights into how aspects of 3DSP are not welcome in the museum. Below is an examination of each curatorial map, what it contains and how 3DSP objects have been depicted in relation to the exhibition concept.

- <u>Concept A. Exhibition by Alister, Curator of Natural Science.</u>

The exhibition concept, (see practice-based submission p.51) detailed a paleontological exhibition with skeletons, biological and replica fossils displayed in the same manner. A large screen depicted the process of fossilisation and 3D scanning. Robotic 3D printed trilobites occupied the far corner for visitors to play with. The exhibition concept was sparse, allowing a dinosaur fossil and its 3D printed counterpart to take centre stage.

- Concept B. Exhibition by Clara, Curator of Social History.

The exhibition used the concept of enlarging objects to display doll's houses in an innovative way (see practice-based submission p.52). In the centre was an enlarged 3D printed dolls house which visitors could sit in. Standard museum cases sat on the outskirts of the exhibition, with a resources area containing oral history excerpts and 3D printed handling objects.

- Concept C. Exhibition by Martha, Curator of Archaeology

The exhibition concept (see practice-based submission p.53) detailed a bronze age coin exhibition featuring multiple examples of 3DSP. Enlarged 3D printed coins were placed at the entrance of the exhibition, with interactive exhibits placed around sides of the gallery space. The main use of 3D scanning was situated at the back of the space, with a section cornered off for a live accessioning and 3D scanning space, which allowed audiences to view the behind the scenes of the curatorial process.

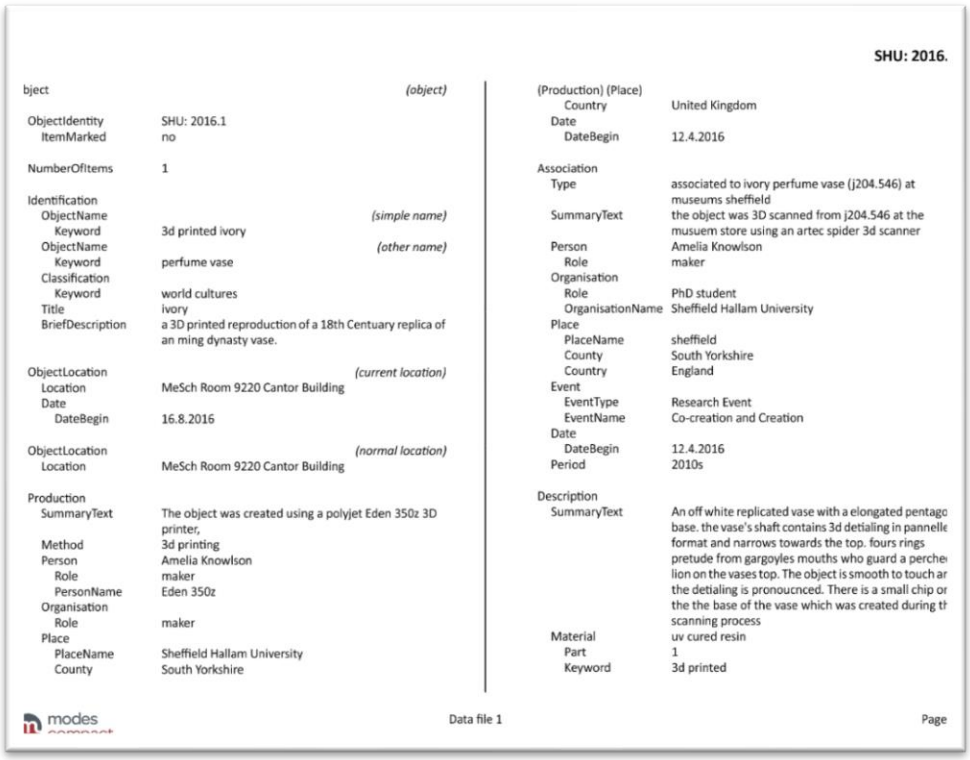
- Concept D. Exhibition by Clare, Curator of Decorative Arts

The exhibition (see practice-based submission p.54) was divided into themes to convey more effectively the complexities of historical Chinese Ivory. Standard museum cases were placed in thematic areas with the museum objects displayed inside. 3D scans and 3D printed versions of the ivories were located in a resource area along with dressing up clothes for children and a reading area. The focus was not on the 3D prints which were used and seen as interpretive aids.

- Concept E. Exhibition by Leighanne, Curator of Archaeology

The exhibition concept (see practice-based submission p.55) used 3DSP to support a show about bronze age burial beakers. 3DSP was used to show how broken pots would have looked when they were whole by using 3D printing to reconstruct missing or damaged pieces. 3D printed works were displayed alongside museum objects and interpretive aids such as the handling of objects.

The resulting exhibition concepts detailed not only a variety of exhibition styles but also revealed how curators perceived 3DSP alongside their core collection and within the frameworks and display standards of the museum. The exhibition concepts corresponded



SHU: 2016.

bject		*(object)*
ObjectIdentity	SHU: 2016.1	
ItemMarked	no	
NumberOfItems	1	
Identification		
ObjectName		*(simple name)*
Keyword	3d printed ivory	
ObjectName		*(other name)*
Keyword	perfume vase	
Classification		
Keyword	world cultures	
Title	ivory	
BriefDescription	a 3D printed reproduction of a 18th Centuary replica of an ming dynasty vase.	
ObjectLocation		*(current location)*
Location	MeSch Room 9220 Cantor Building	
Date		
DateBegin	16.8.2016	
ObjectLocation		*(normal location)*
Location	MeSch Room 9220 Cantor Building	
Production		
SummaryText	The object was created using a polyjet Eden 350z 3D printer,	
Method	3d printing	
Person	Amelia Knowlson	
Role	maker	
PersonName	Eden 350z	
Organisation		
Role	maker	
Place		
PlaceName	Sheffield Hallam University	
County	South Yorkshire	

(Production) (Place)	
Country	United Kingdom
Date	
DateBegin	12.4.2016
Association	
Type	associated to ivory perfume vase (j204.546) at museums sheffield
SummaryText	the object was 3D scanned from j204.546 at the musuem store using an artec spider 3d scanner
Person	Amelia Knowlson
Role	maker
Organisation	
Role	PhD student
OrganisationName	Sheffield Hallam University
Place	
PlaceName	sheffield
County	South Yorkshire
Country	England
Event	
EventType	Research Event
EventName	Co-creation and Creation
Date	
DateBegin	12.4.2016
Period	2010s
Description	
SummaryText	An off white replicated vase with a elongated pentago base. the vase's shaft contains 3d detialing in pannelle format and narrows towards the top. fours rings pretude from gargoyles mouths who guard a perche lion on the vases top. The object is smooth to touch ar the detialing is pronoucnced. There is a small chip or the the base of the vase which was created during th scanning process
Material	uv cured resin
Part	1
Keyword	3d printed

modes

Data file 1

Page

Figure 7 Example of the Accessioning task completed by Clare.

to the accessioned records (see practice-based submission pp.39-40), which revealed the perceived role and position of 3DSP objects in the collection. Below are examples of the accession with the complete set illustrated in the practice submission.

The Accession intervention is directly inspired by the Accessioning process curators undertake in order to bring an object legally into the care of the museum. The aim of the Accession intervention was to understand how curators perceive 3DSP in relation to their collection and to reveal the frustrations of doing so by challenging the cataloguing system of the museum's documentation system.

Embedded within the curatorial interventions are curatorial perceptions that indicate how 3DSP works with and against the frameworks of the museum, depending on the context of the collection in question. It suggested to a more complex relationship between museum frameworks, standards and expectations than I had originally expected. The Museum Sheffield Residency seemed to highlight how the curator's authority is restricted by

regulations imposed by external and internal sources. Ideas on how to work with 3DSP are thus limited by the frameworks and the protocols of the museum.

4.43 Stories from the East: The Grice Ivories

The co-curation of 'Stories from the East' consisted of myself working with Clare Starkie from Museums Sheffield to design and implement a way of integrating 3DSP objects into an already scheduled ivory exhibition. I used the curation of the exhibition to explore space and layout (see practice-based submission pp.35-38). The exhibition was also a way for me to test and explore boundaries. By using the exhibition as a method research, I was able to test the limits of 3DSP objects inside cases, as well as the perceived restrictions of considering the such objects a as 'museum object'.

During the design and installation phase of the exhibition, I played with notions of space language and layout. Positioning objects either inside or outside of the museum case served as a powerful tool for how 3DSP museum objects are perceived. The act of playing with layout and objects meant I was co-curating the exhibition with for the purpose of exploring how curators perceived 3DSP within the gallery context. It moved the questions I was asking from the hypothetical and to the real-word, and presented knew challenges to for the curators who had to think about the audiences of Weston Park Museum.

4.5 The British Museum Residency

4.51 What is the Dataset?

The data for The British Museum Residency consists of a 'Curators' Box'. The box contains a series of curatorial interventions that sought to ascertain curatorial perceptions relating to the integration of 3DSP in museums. The interventions were evaluated and then fed back to the corresponding curators.

At the British Museum, I worked in the Digital Humanities team run by Daniel Pett. During this time, I responded and contributed to 3D commissions by curators from across the museum. In return, the curators completed the curator's box (see figure 8). They were free to add to and customize the box as they saw fit. Participating curators from across the museum chose to decorate the boxes, adding images of the objects to be 3D scanned to the outside surfaces of their box.

Figure 8 Image of the 'Curator's Box'

The data for The British Museum Residency consists of a series of curatorial tasks presented in a box, named 'The Curator's Box'. The box was given to the curators during the 3-month residency at The British Museum. Below is an outline of the tasks that the boxes contained.

- A flow chart, designed to show the curatorial intention
- A series of questions around how 3D printing is being used in the museum
- Diary pages

In addition to the tasks inside the curator's boxes, the boxes were used to document 8 curatorial projects that used 3DSP technology, providing real-world examples of the use of 3DSP within the museum. The residency also gave insight into curatorial perceptions of the

technology and its use over an extended period of time. In each case the 3DSP projects/commissions were initiated by the curator and sought to use 3DSP to support object research.

The various projects for the 'Curators Box' at The British Museum were as follows:

- The Votive Offering, curated by Thomas Keily, curator of Cyrus and the Neolithic

This project sought to use 3DSP to explore how multiple layers of interpretation help to reveal the complexities of a polylingual stone.

- The Basse-Yurtz Flagons, curated by Julia Farley, curator of European Iron Age

This project sought to recreate accurate 3D replicas of the flagons paid for by The Moselle Museum. Currently the museum is debating how these 'loans' will be managed and who will have access to them. The Basse Museum intends to buy the scan and print outright.

- The Alabasters, curated by Lloyd de Beer, curator of Medieval Europe

In collaboration with The Victoria and Albert Museum, 7 alabaster sculptures were 3D scanned and uploaded to Sketchfab to provide a joint resource for curators across The British and Victoria and Albert Museum.

- The Nereid Frieze, curated by Alexandra Villing, curator of Greek Pottery

This object had been rejected for loan, on the grounds that it has been consolidated and the requesting museum only wanted a small section of the Frieze. The plan was to develop a high-resolution 3D scan of the frieze and loan it out as a digital loan.

- The Mummy Masks, curated by Marie Vanerbush, curator of Ancient Mummies

This project blurred the lines between the curatorial and the scientific. Using CT, X-ray and laser scans, we created a 3D print of a mummy mask and a similar shaped mould to determine if one was made from the other.

- The Luzira Head, curated by John Giblin, Head of Africa, Oceania and the Americas

This project aimed to generate a 3D artefact to assist the handling and engagement collection in Nigeria. There have been multiple attempts by Nigeria to repatriate the head and the British Museum is now part of a task force to find a solution.

- The Gayer-Anderson Cat, curated by Neal Spencer, Keeper of Egypt and the Sudan

The Gayer-Anderson Cat. This project used both CT, X-ray and laser scans to explore the production of the cat as both a 1st Century BC object and also as a 1930s object owing to its extensive repair during this period.

- The Ringlemere Cup, curated by Neil Wilkin curator, of The Bronze-Age Collection

This project sought to create a digital replica of the Ringlemere Cup to support audience and outreach engagement.

The boxes exist as both a method of collecting data for the 3DSP projects and as a creative method. They are directly linked to the 3D scans produced as part of the 3DSP project and, to some extent, exist as a way of documenting 3DSP projects within the museum. Although not conceived to operate in such a way, 'The Curators Boxes' are separate from the museum's documentation system and are thus free from the cataloguing restrictions of the museum.

4.52 The British Museum Residency: Initial Reflections

The data from The British Museum Residency provided real world contemporary examples of how 3DSP could, and is, being used in the museum. The data showed how curatorial perception regarding 3DSP objects changed as the objects came into contact with different curatorial and non-curatorial departments. It seems to highlight how departmental frameworks and standards, which seek to order and structure object information, both physical and digital, changed how curators perceived the use of 3DSP objects.

Curators across The British Museum saw 3DSP as a tool for enriching audience experience as well as their own practice, yet struggled to see where 3DSP sat within the museum or whether the objects and scans produced from this technology should be a part of the collection. There seemed to be a dualism at play between the perceived benefits and possibilities of 3DSP and the standards and frameworks of the museum. Furthermore, the environmental, social, and cultural context of the collection from which the object originated, seemed to be an important

factor in how 3DSP was used, especially when culturally sensitive objects were being considered for 3D scanning or printing.

The data inside 'The Curator's Box' revealed the types of data curators deemed important, not only for approaching and completing 3D digital projects, but for documenting them as well. Such a method appears to offer a new way of thinking about 3D digitisation. It revealed systems of hierarchical value, knowledge transformations and considerations of control and access. Embedded within this data set are drawings, critical diagrams, annotations and reflections on curatorial practice and that of the museum (see practice-based submission p.91, p.107 and pp.115-116).

The overall study revealed the complexity of using 3DSP and of integrating it into the museum and subsequently, into curatorial practice. Potentially, it provides a new way of looking at and understanding 3D digitisation within the museum, both online and physically, while alluding to the changing role of museum curatorial practice.

4.53 An Object in Transition

The curation and installation of 'An Object in Transition' took place during the run up to the annual Heritage Consortium Conference 2017. Throughout the Acclimatisation Study and the two residencies there had been a prevailing question about the position of 3DSP in the museum, especially when the 3DSP object is perceptually different to the original museum object. I wanted to explore this question visually to provide myself and audience with a greater insight into this problem.

During the curation phase of the exhibition, I explored the texts and 3D scans I had amassed. I started to pull apart each aspect of the 3DSP process. I questioned whether the data produced by each process could be considered as a museum object (see practice-based submission pp. 113- 122). I pondered who were the individuals classifying 'museum objects' and came to visualise and juxtapose each part of the 3DSP process against quotes and questions from curators at The British Museum.

I used the exhibition as a research method to examine the role and position of 3DSP in museum. Once the exhibition was installed, myself and audiences were able to use to the exhibition as a sounding board to reflect upon questions such as: how does the object change

as it moves through the 3DSP process? What does 3DSP do to our understanding of a museum object, and what is the role of this new technology?

4.54 Frustrating the Linear

The final exhibition I developed sought to explore how 3DSP challenges the linear nature of museum categorisation strategies. Both the design and curation phases were used a method of research. I was interested in how in the inclusion of 3D datasets would or would not work within the confines of the museum system. I questioned what data was being omitted during this process and sought to develop an exhibition that allowed me to test, explore and even develop new ways of seeing connections between data.

'Frustrating the Linear' was a performance piece where the act of hanging and re-hanging data for one museum object (see practice- based submission pp.130-141) was considered as a mode of curation. The performance took place in front of passing audiences at the Post Office Gallery. It was also recorded using time lapse photography to show how the focus on different data characteristics formed new data relationships and affected our understanding of how museums document their objects. I used the exhibition to layer data, images and text (see practice-based submission pp. 133-138) in an attempt to create new data collections and simultaneously frustrating the traditional systems of categorisation.

4.6 Summary

In summary, the initial reflections for the three data sets brought to light to a complex relationship between the curator, the museum and the object that went beyond traditional assumptions of the replica in the museum. There was a simultaneous wish to engage with 3DSP and a concern about its integration into the museum that needs to be considered in greater detail.

Across the three studies, there seemed to be a dualism at play between the perceived benefits and challenges of using 3DSP in the museum. The three data sets highlighted how curators saw the benefits of the 3DSP, but struggled to see how it would fit within the confines of the museum's traditions, practices and culture. It suggested notions of value and relational links between museum data and 3D datasets of museum objects.

There seemed to be a desire to explore the possibilities of 3DSP, either through object handling, experimentation or creation of 3D objects as a form of curatorial practice. The desire to explore what 3D scanning and printing does, and can do, within the context of the museum, raised questions about how the technology can impact on the daily tasks of curators, as well on as their own personal approach to the practice. The above was especially the case with curators at Museums Sheffield who did not have a digital team to carry out 3D scanning and printing for them.

The subsequent chapters are an examination of the data and themes mentioned in the above sections. Ch.5 'A Curatorial Intention' explores the curatorial position, Ch.6 '3DSP Objecthood and Curatorial Practice' examines 3DSP's impact on practice, Ch.7 'The Museum and The Digital' investigates the logistics of implementing 3DSP into the museum.

5.The Curatorial Intention: The Role and Position of 3DSP in the Museum

5.1 Introduction

This chapter examines how participating curators perceived the use of 3DSP within their museum and how this perception influenced the way they curated with 3DSP. It explores how each curator worked with and against the desired practices of the museum and critically reflects upon how the use of technology in the museum impacts on the changing role of the curator.

The chapter draws on the curatorial interventions, from both The British Museum and Museums Sheffield, and the exhibition 'Stories from the East: The Grice Ivories' and 'An Object in Transition'. Here the processes of curating were under examination in order to assess how curators position their way of curating with 3DSP within the frameworks and desired outcomes of the museum.

The chapter first examines how curators viewed 3DSP in the museum, after which it examines this positionality in practice. The chapter then examines how curators from Museums Sheffield and The British Museum responded to 3DSP being integrated with the practices of the museums. It provides practical examples of this curatorial response, before assessing how such responses can cause a shift in museological perspective.

Embedded within this chapter are concerns about how the integration of 3DSP in the museum might affect it. These concerns are combined with a recognition that 3DSP could enrich current museological practices, including object research, audience engagement and outreach strategies. It is important to mention that this chapter is meant to serve as an overview, outlining the curatorial perspective and how it influences the way curators curate, before narrowing the focus in the subsequent chapters to objecthood, practice and the general logistics of managing 3DSP in the museum.

5.2 The Curatorial Position

The curatorial position is a term used to show how curators perceive and curate with 3DSP in the museum. It encompasses all the curatorial processes from accessioning and documentation to display and includes the subjective decision-making procedures that are often involved in the act of curating. Before discussing the effect of 3DSP on the role of the

curator and museum, it is important to document first the positions held by participating curators. The list below is an account of how each curator perceived 3DSP in the museum. This list is supported by my own observations of curators interacting with 3DSP and with the curatorial interventions.

5.21 Museums Sheffield

Clare: Clare had previous experience and knowledge of 3DSP from the JISC project and was keen to engage with 3DSP and use the technology within her collection.

Clara: Clara struggled to see how 3DSP could be used in her collection, as the Social History collection already contained replicas and handling objects were not a new concept.

Alister: Alister had a background in Computer Science and so had an understanding of how 3DSP worked. He was keen to use 3DSP in his collection and had a particular interest in creating large scale replicas of prehistoric bones.

Leighanne: Leighanne had some knowledge of 3DSP, mainly from newspapers and magazines. She was keen to use 3DSP in her collection, particularly in relation to reconstructing bronze-age burial beakers.

Martha: Martha was interested in 3DSP but had concerns about how the technology would impact on her collection.

5.22 The British Museum

John: John was concerned about the use of 3DSP in his collection, particularly in areas of cultural sensitivity. He had no previous experience of 3DSP and, despite recognising the value of 3DSP in terms of increasing access and engagement, he was worried about using it with non-experts.

Neal: Neal had a lot of previous experience and was used to experimenting with 3D technology from his time working in the field. 3DSP has been used extensively to support Archaeological and Egyptology field work. He spoke about using 3D technology to reveal the inside of sarcophagi digitally and was keen to experiment with the Artec Scanners.

Marie: Marie was also keen to experiment with 3DSP. She had experience of using 3D technology from managing Egyptological touring exhibitions that used the technology to reveal hidden amulets inside mummies. She was keen to use 3DSP on her mummy masks.

Lloyd: Lloyd was uninterested in 3DSP. He had no experience of using the technology and despite seeing a value in increasing access and engagement, he had no interest in experimenting with the technology.

Thomas: Thomas had an interest in experimenting with 3DSP but purely from an object centric perspective. His goal was to increase engagement with one object. He had limited knowledge of using 3DSP but was keen to create a 3D scan of the Votive Offering.

Alexandra: Alexandra had some knowledge of using the technology within her collection through a collaboration between The British Museum and The Acropolis Museum. She recognised the value of 3DSP and was keen to experiment further with it.

Julia: Julia had prior knowledge of 3DSP from a previous enquiry into whether photogrammetry could be used to help 3D scan the Basse-Yurtz Flagons project, although she had never practically used the technology. She was keen to see how 3DSP could be used to share the Flagons with a French museum.

Neil: Neil was keen to explore the possibilities of 3DSP and had some knowledge of 3DSP but no practical experience of using the technology.

The interactions, behaviours and approaches to the use of 3DSP within the museum, listed above, help to form an overview of each curator's perspective of the technology. In practice this can been seen through the curatorial intervention in the practice-based submission (see pp.50-53 for the exhibition concepts from Museums Sheffield and pp.93-96 for examples of the curatorial flow charts from The British Museum). The subsequent section of this chapter is an exploration of the curatorial position of 3DSP in practice.

5.3 Positionality in Practice

The curatorial interventions completed by curators at Museums Sheffield and The British Museum revealed how curators perceived the use of 3DSP in the museum and how their ideas about the technology affected how they curated 3DSP objects. Curators across both museums used their curatorial interventions to document and draw how they would use 3DSP in the gallery context. The exhibition concepts from Museums Sheffield revealed a desire to encourage audiences to explore new object narratives. For example, Martha created a live

accessing and scanning station (see figure 9) and Leighanne added 3D printed enlargements to provide audiences with close ups of object details (see figure 10).

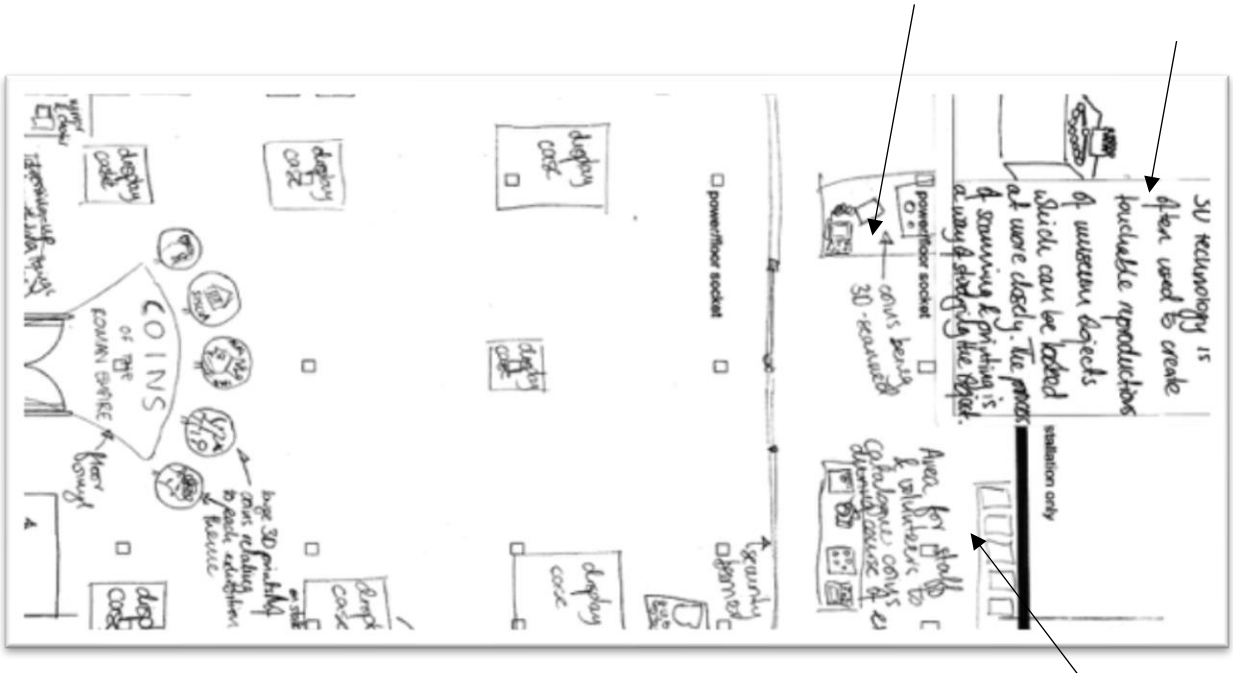


Figure 9 A close up of Martha's exhibition concept

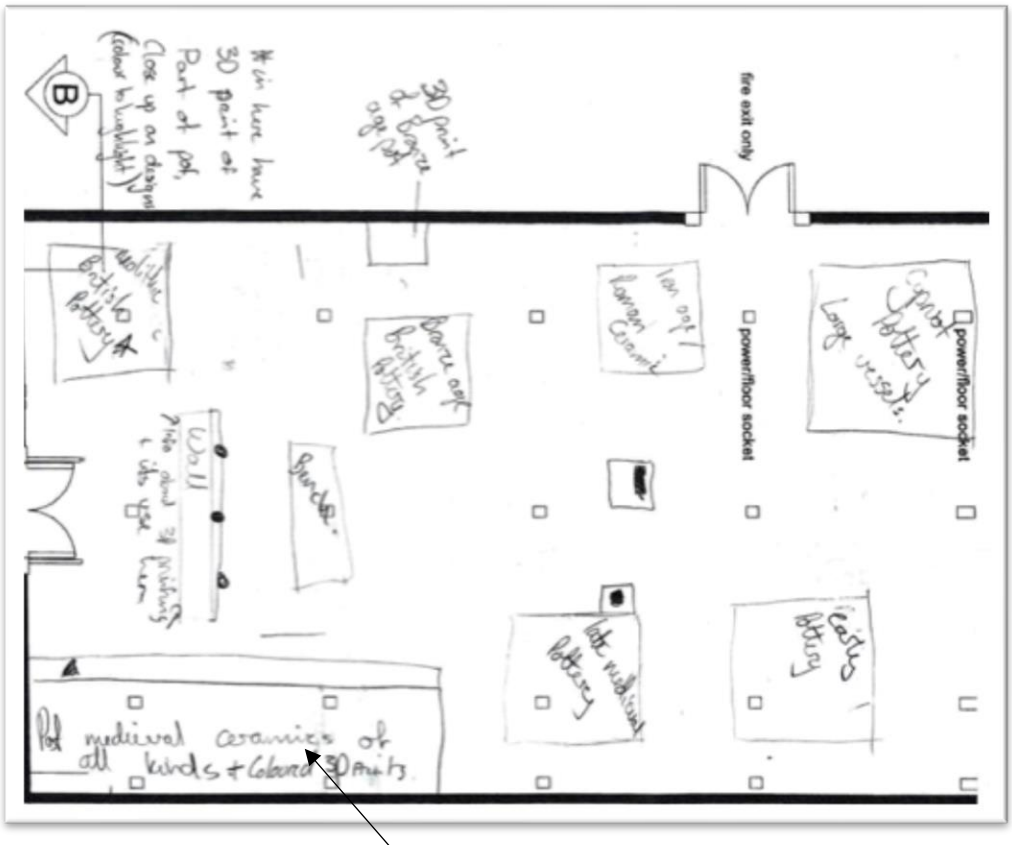


Figure 10 A close up of Leighanne's exhibition concept

Martha's exhibition concept (see figure 9) documents an accessioning and live 3D scanning platform which she used to open up the curatorial process and allow audiences to see more of what curators do. This deviation from traditional museum practice was accompanied by the use of 3DSP to provide new object insights and narratives as seen in Leighanne's exhibition concept (see figure 10) and the other exhibition concepts (see practice-based submission pp.51-55).

The British Museum curators wished to use 3DSP in a different way: for the sharing of objects and the dissemination of object information. There was a desire to share objects beyond the four walls of the museum. This desire though was not uniformly acknowledged across all the curators, for a curator's position with regard to 3DSP was informed by the practices of his or her curatorial department, prior experience with 3DSP and the cultural and political context in which the collection exists. For example, curators from the same curatorial departments, such as Neal and Marie from the Department of Egypt and Sudan (DES) and Julia and Neil from the British and European Prehistory Department (BEP), positioned 3DSP in the same way. For Neal and Marie, there was a focus on research and increasing audience engagement. Both curators actively carried out research that used 3DSP technology. In their diary they write,

In Egyptian mummies: ancient lives, 3D prints raised new interest for visitors who were very enthusiastic at the idea of accessing these unique objects not visible for thousands of years. (Marie – The British Museum).

In the gallery the Gedelian Man Virtual Autopsy Table (2013) has been very successful in retention 96% of time and more importantly people look at the mummy as a result. (Neal – The British Museum).

Whereas Julia and Neil, both members of the BEP department, saw the value of 3DSP being embedded in access and engagement. Their comments centred on using 3DSP to engage audiences. Julia wrote about the possibilities that 3DSP could bring to the museum, including allowing audiences olfactory and tactile experiences previously denied to them. An idea furthered by Neil, who wanted to use 3DSP to create online 3D scanning for audiences to experience whenever they wished.

People are excited by the new technology and possibilities and especially enjoy being able to touch and handle objects and scans (Julia- The British Museum).

For 3D scans (e.g. online) the value is immediacy, being able to explore an object in all dimensions @ their leisure (Neil – The British Museum).

Yet Julia's and Neil's focus on using 3DSP to support access and engagement is perhaps because the BEP department's objects are not culturally or politically contentious, unlike those of John, from the Department of Africa, Oceania and the Americas (DAOA). As a result, BEP curators have the potential to explore freely the uses afforded by 3DSP without concerns about the political and cultural ramifications.

However, despite the different perspectives in approaching 3DSP in the museum, the outcome was generally the same: objects were created and eventually displayed or disseminated online. This is seen in The British Museum's SketchFab account, which currently displays 20 out of 28 of the 3D scans I created and in the combined flow chart interventions (see figure 11) which illustrate the responses from all participating curators at The British Museum.

The combined chart revealed the ways curators desired to curate a 3D printed museum object, illustrating a route through displaying the 3D printed object in a glass case with other objects, not scaling it and printing it in full colour. Curatorial direction is thus centred not only on creating and sharing objects but also on accuracy, an aspect of 3DSP explored more in Ch.6 '3DSP Objecthood and Curatorial Practice' and Ch.7 'Museum and The Digital'.

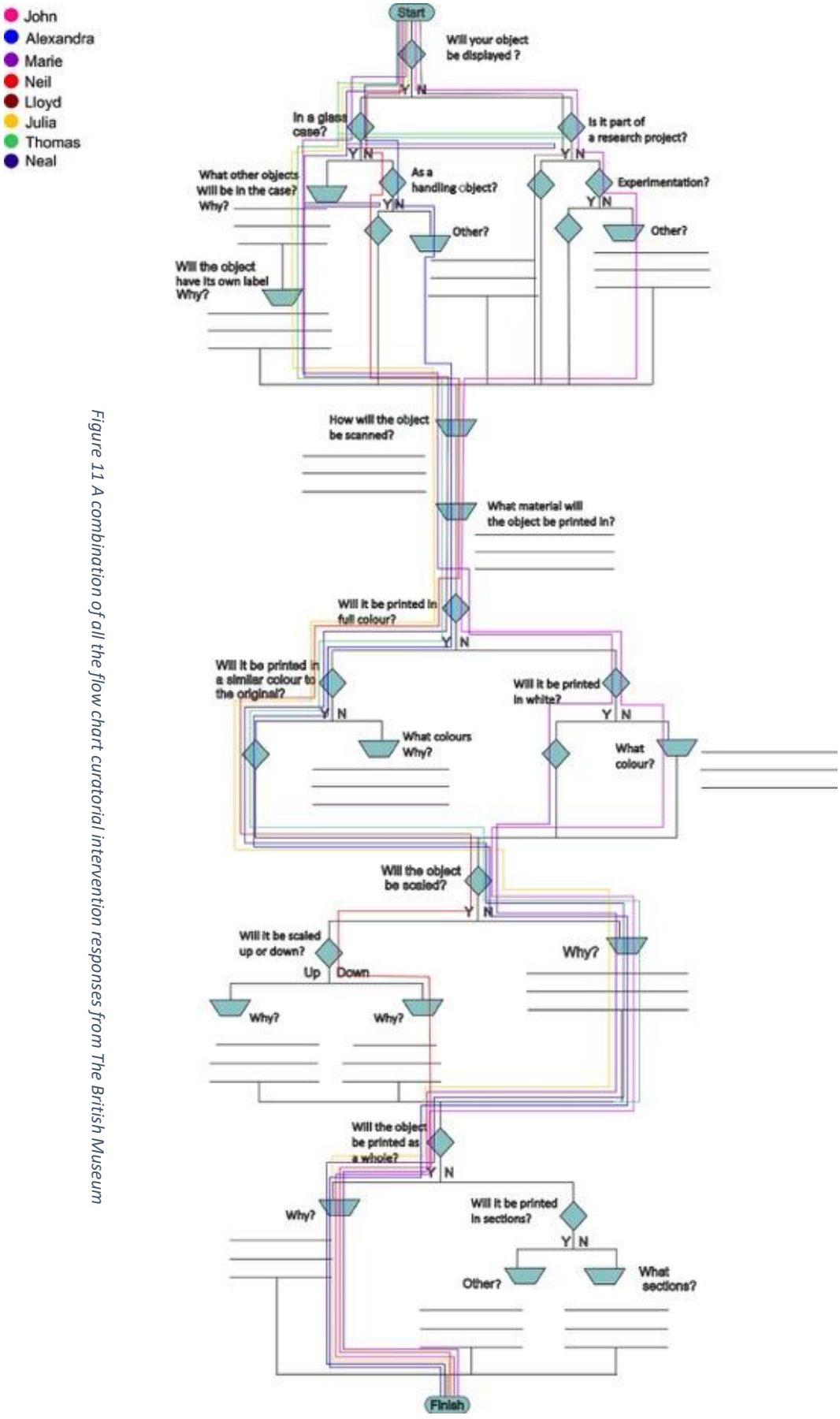


Figure 11 A combination of all the flow chart curatorial intervention responses from The British Museum

Within the curatorial interventions were drawings and text that also illustrated how curators saw audiences engaging with 3DSP (see practice-based submission p.91, p.107 and pp.115-116). The British Museum curators wrote about their visitors playing with 3D scans and handling 3DSP objects. The curators at Museum Sheffield drew enlarged 3DSP museum objects, 3DSP handling objects and, in one concept, a fully articulated 3DSP dinosaur skeleton.

The exhibition concepts show how curators such as Clare, Clara, Leighanne and Alistair, (see practice-based submission pp.51-55) who come from a variety of curatorial departments, wanted to use 3DSP to encourage audiences to experience objects in new ways. For example, Alistair included 3D printed remote-controlled trilobites in his concept, as a form of play (see figure 12). He envisioned audiences remotely controlling the 'toys' which would mimic the way a real trilobite would move. This consequently allowed audiences not only to play with the exhibits but also to learn about how trilobites moved. This form of play was also noted by British Museum curators and is explored in greater depth in Ch.6 '3DSP Objecthood and Curatorial Practice'. However, it is possible that this form of experimental engagement is only imaginable because the curator's collections are not contentious or politically charged.

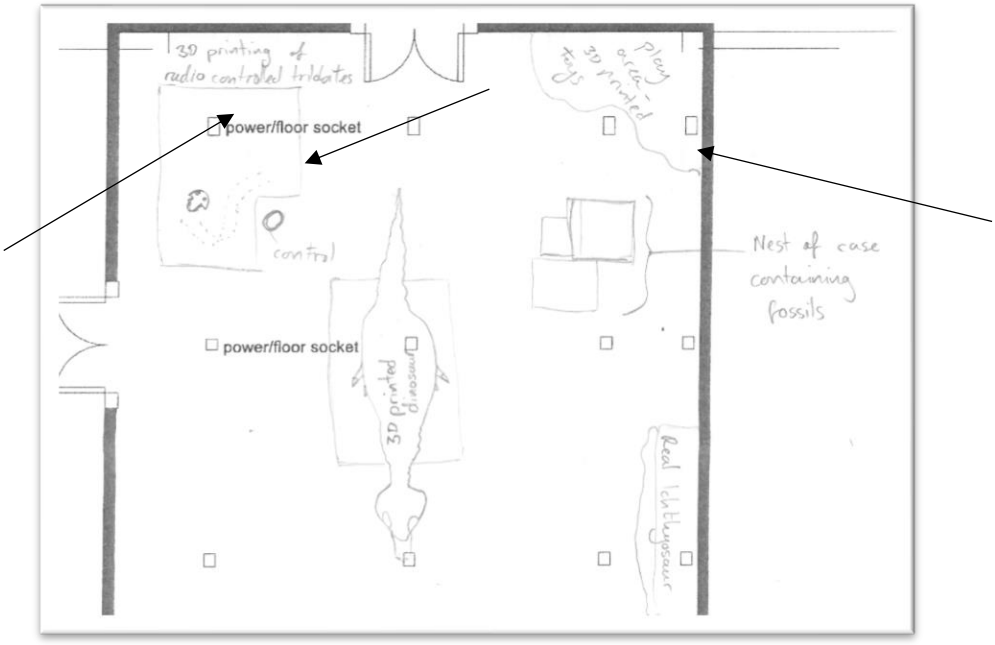


Figure 12 A close up of Alister's exhibition concept

John, who at the time of the residency was Head of the DAOA, used his audience questions and diary writings to critique the use and role of 3DSP, especially with regard to questioning whether scanning African objects could perhaps be considered as a new form of colonialism.

Is it ethical to make 3D resources of important cultural items? Is this colonialism, ownership, appropriation or exploitation? (John – The British Museum)

John's comment refers to how 3DSP could be used to create replica objects of artefacts that once belonged to foreign countries, without their express permission, a point explored more fully in Ch.7 'The Museum and The Digital'. There is currently a debate around where the ownership and copyright of a 3DSP object would lie. This is especially prevalent in the museum, where the control of access to 3D scans and prints is debated. It is, therefore, understandable that curators caring for politically and culturally charged objects should question the ethics and morals of using 3DSP in the museum. However, despite his concerns, John also recognised the value of using 3DSP as a tool for sharing objects.

3D printing enables the sharing of objects with other museums and audiences in that are ways not possible with objects the permanent collection (John – The British Museum).

While, on the surface, John's statement is one of recognition of the value 3DSP can bring to the museum, it is also a statement of separation. John's use of the word 'permanent' implies that he thinks 3DSP objects are not part of the museum collection or should not be given the same level of protection as accessioned objects. Here, John's comments highlight how one's opinion of 3DSP does not exist in isolation. The political and cultural context of John's collection influenced his thoughts on 3DSP, which in turn affected how he curated 3DSP objects.

However, while a curator's departmental practice and the cultural context in which the collection operates affect how the curator sees 3DSP, it is not the only defining factor. During the Acclimatisation Study the curators' opinions developed in line with their exposure to 3D scanning and printing. At the start of the project, Museums Sheffield curators had no practical experience of 3D scanning and printing and thus their perception of the technology was initially one of apprehension. However, in the final scanning phase of the project, discussions centred predominately on the meaning of the objects and how they could learn from them. During discussions, curators came together to explore replicas of museum objects that they

had not previously encountered. For example, the curator of natural science, when handling the 3D printed Bronze-Age Beaker, asked the curatorial assistant of Archaeology if the etched detail was symbolic or textual. This example of 3DSP facilitating cross-curatorial conversations is explored more fully in Ch.6 '3DSP Objecthood and Curatorial Practice'. Yet for the purposes of the discussion in this chapter, the development of 3DSP knowledge is seen in my Acclimatisation Diary (see figure 13) where I state how curators were more interested in 3DSP then than they had been in previous sessions and I list some of their comments from the most current 3DSP experiment.

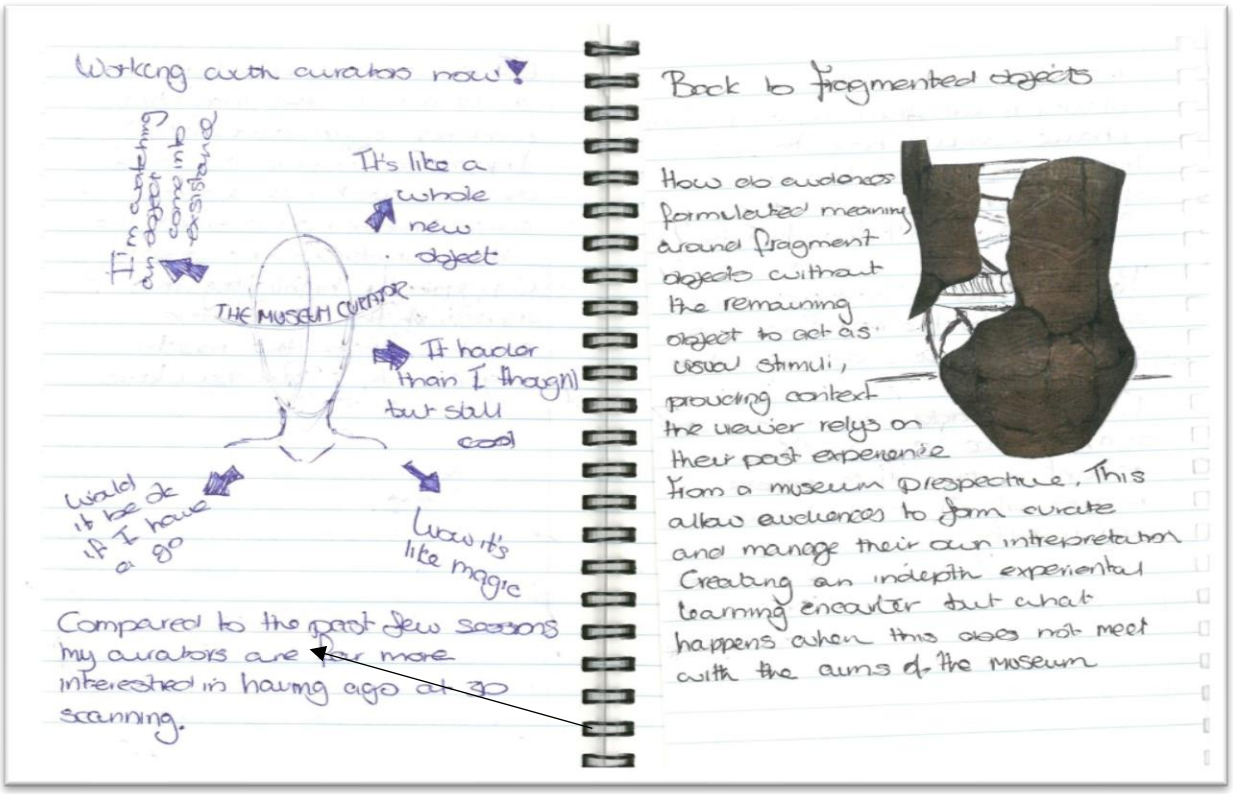


Figure 13 An example diary page from The Acclimatisation study.

With the above discussions in mind, the curatorial perception of 3DSP within the museum is influenced by a combination of factors: the way the curatorial department responds to objects and the cultural context of their collection and technological experience. Each defining factor does not exist in isolation and does not necessarily have equal weight with other factors. Furthermore, it can be argued that the position of the curator does not directly relate to the way curators want to curate the technology, as they must work within the framework of the museum.

As Ramírez (1996) argues, curators, far more than other heritage professionals, depend on the infrastructure that supports their practice. Curators are thus placed within an imposed yet restricted position of power. As a result, the way 3DSP is used in the museum is not purely defined by the curator. 3DSP exists in a transitory space defined by the museum's traditions, practices and politics. Such a space is not rigidly defined but is fluid, continually shifting with the complex social, economic, political and cultural contexts in which it is situated.

This fluid and transitionary space was explored by myself when devising the exhibition 'An 'Object in Transition'. The exhibition was an installation that visualised each stage of the 3D printing process whilst documenting how a museum object was transformed in different museum spaces (see figure 14).

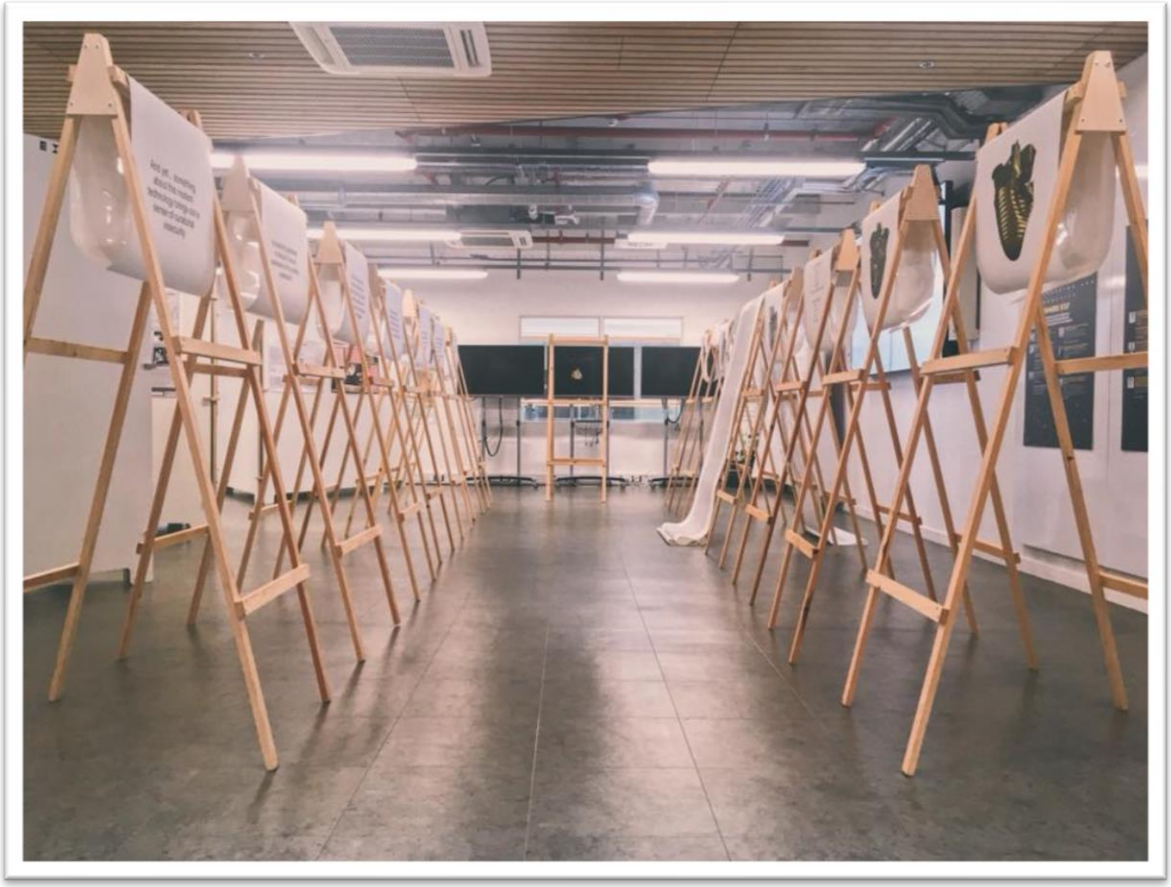


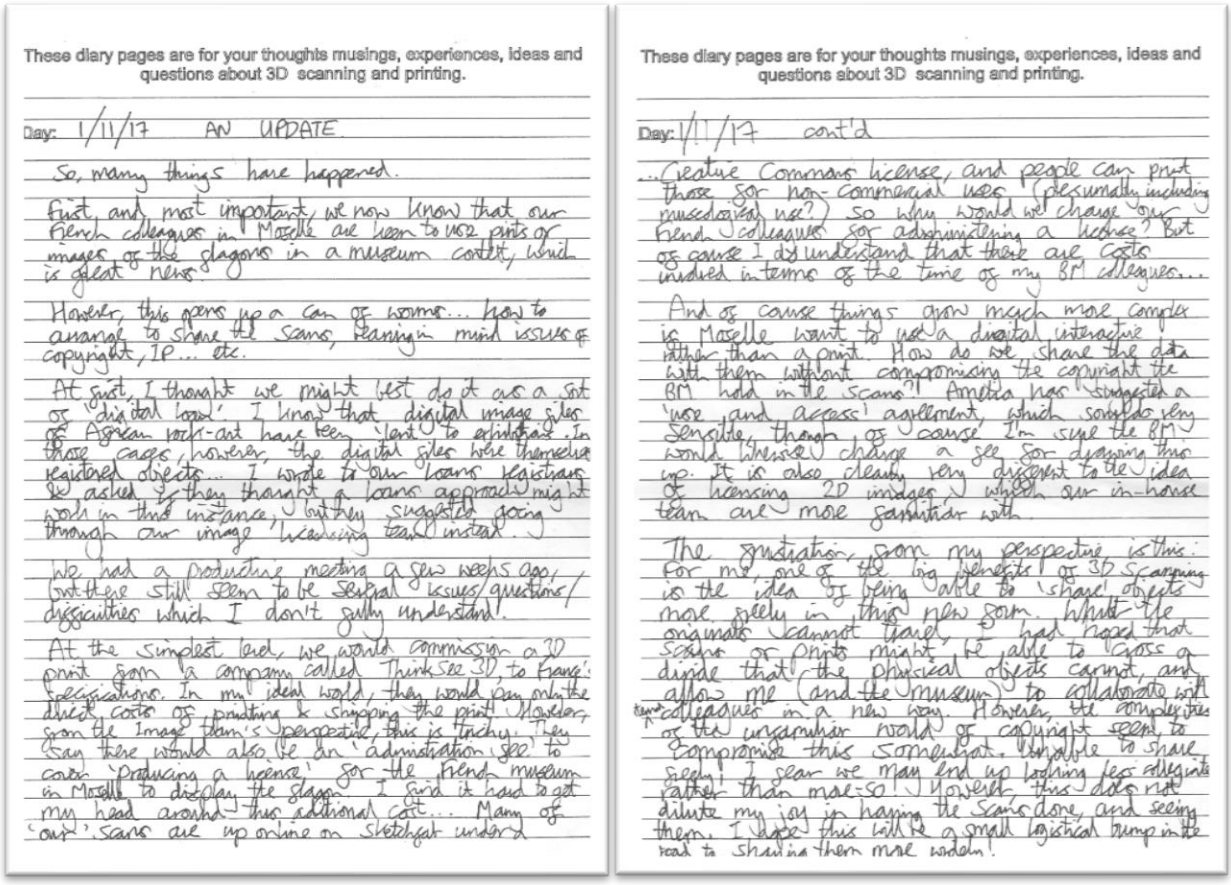
Figure 14 An image of the exhibition 'An Object in Transition' shown at the Heritage Consortium Conference 2018

Here, each stage of the 3DSP of process is visualised and positioned opposite quotes from curators, which, when considered together, allude to how the perception of 3DSP changes as it moves through the museum. The aim of the exhibition was to develop findings that positioned 3DSP as a political and cultural tool that transitioned through the museum,

simultaneously challenging and enriching practice. Audiences at the exhibition were confronted by quotes that questioned the use of the technology, while concurrently expressing its potential to support audience engagement, object-based research and curatorial practice. A more extensive visual record of the exhibition, as well as the development phase, is shown in the practice-based submission (see pp.109-113).

5.31 Transitioning Through Spaces

The Museums Sheffield and British Museum residencies enabled me to show how 3DSP objects are perceived differently as they move through the museum. Management, non-curatorial and curatorial departments responded to 3DSP objects in different ways, based on the traditional practices of their department, which ultimately affected the outcomes, time-scale and overall conversation surrounding 3DSP in the museum. Such was the case of the Basse-Yurtz Flagon project, which sought to create a 3D print of the Flagons for a museum in Moselle.


These diary pages are for your thoughts musings, experiences, ideas and questions about 3D scanning and printing.

Day: 1/11/17 AN UPDATE

So, many things have happened.

First, and most important, we now know that our French colleagues in Moselle are keen to use parts of images of the flagons in a museum context, which is great news!

However, this opens up a can of worms... how to arrange to share the scans, bearing in mind issues of copyright, IP... etc.

At first, I thought we might best do it as a 'digital loan'. I know that digital image files of African craft-art have been 'lent' to exhibitions. In those cases, however, the digital files were themselves registered objects... I wrote to our loans registrars & asked if they thought a loans approach might work in this instance, but they suggested going through our image licencing team instead.

We had a productive meeting a few weeks ago, but there still seem to be several issues/questions/difficulties which I don't fully understand.

At the simplest level, we would commission a 3D print from a company called ThinkSee 3D, to 'hang' collections. In my 'ideal world', they would pay only the direct costs of printing & shipping the print. However, from the Image Team's perspective, this is tricky. They say there would also be an 'administration fee' to cover 'producing a licence' for the French museum in Moselle to display the flagon. I find it hard to get my head around this additional cost... Many of 'our' scans are up online on Sketchfab under a

These diary pages are for your thoughts musings, experiences, ideas and questions about 3D scanning and printing.

Day: 1/11/17 cont'd

...Creative Commons license, and people can print those for non-commercial uses (presumably including museological use?) so why would we charge our French colleagues for administering a licence? But of course I do understand that there are costs involved in terms of the time of my BM colleagues...

And of course things grow much more complex if Moselle want to use a digital interactive rather than a print. How do we share the data with them without compromising the copyright the BM hold in the scans? Amelia has suggested a 'use and access' agreement, which sounds very sensible, though of course I'm sure the BM would likewise charge a fee for drawing this up. It is also clearly very different to the idea of licensing 2D images, which our in-house team are more familiar with.

The frustration from my perspective is this: for me, one of the big benefits of 3D scanning is the idea of being able to 'share' objects more freely in this new form. Whilst the originals cannot travel, I had hoped that scans or prints might be able to cross a divide that the physical objects cannot, and allow me (and the museum) to collaborate with our colleagues in a new way. However, the complexities of the unfamiliar world of copyright seem to compromise this somewhat. It's possible to share freely, I fear we may end up looking less altruistic rather than more so. However, this does not dilute my joy in having the scans done, and seeing them. I hope this will be a small logistical bump in the road to sharing them more widely!

Figure 15 Diary pages written by Julia.

The project was delayed in order to work out the complexities of a licensing agreement between The British Museum and Moselle. Figure 15 consists of two pages from Julia's diary

where she alludes to the complexities of organising the agreement. Her writings reveal how the project became delayed whilst simultaneously exposing how the 'Image and Licensing Team' perceived the use of 3DSP quite differently from how curators viewed it. Julia uses phrases related to access rights, such as 'digital loan', 'use and access agreement' and a 'Creative Commons License' to express how the 'Image and License Team' perceive 3DSP objects. Here, use of the technology is not about objecthood, but about protecting both the object and the museum. It shows that, in the case of large museums, the integration of 3DSP is not solely a curatorial concern but affects multiple aspects of the museum.

5.4 Shifting Perspectives

During both residencies, curators working directly with 3DSP came to disagree with members of non-curatorial departments, especially with regard to access, as seen in Julia's diary (see figure 15) and to the aesthetics of displaying 3DSP. These disagreements related to a single aspect of 3DSP's integration and not to the entire concept of its use within the museum. The integration of 3DSP is not apolitical. Its addition to the museum has implications for the museum's traditions, practices, documentation strategies and curatorial practice among other things. As a result, the integration of 3DSP has the potential to affect every aspect of the museum, causing the curatorial perspective to shift between the desires of the museum and personal wishes of experimenting with the technology.

Shifts in curatorial perception relating to 3DSP were noted during the Museums Sheffield residency. The residency and the Acclimatisation Study at Museums Sheffield had progressed with no mention of colour or colour accuracy, as explored in my own diary (see practice-based submission p.45). Yet, when co-curating 'Stories from the East: The Grice Ivories', it became clear that senior members of non-curatorial departments were concerned about whether 3DSP objects would look too much like the originals. For this reason, the exhibition was staged with in-case 3DSP objects printed in white. Figures 16 and 17 show two examples of the white 3D details. The objects were printed in polylactic acid, a material that cures in UV light, giving objects a heavy but waxy texture. Figure 16 shows an inscribed detail from an arm rest; the detail was enlarged to show audiences the intricacy of the inscription and to enable a translation to be made.

Figure 16 A photograph of the 3D printed detail from 'Stories from the East'

Figure 17 A photograph of the enlarged 3D printed fish and insects

However, audiences would have been able to see the inscription better if the 3D printed detail had been printed in colour because of the colour contrast on the ivory object (see practice-based submission pp.45-46). The motive behind the 3D printing of the fish and insect details seen in figure 16 was the same as for the 3D printing of the inscription: that of creating

additional object narratives. Here, it can be argued that the concerns and decisions of the non-curatorial museum members actually hindered audiences from discovering the inscriptions, as they were hard to distinguish from the background of the 3D printed detail. This is a point which is supported by Clare who, during the installation phase of the exhibition, stated,

'I would have preferred the objects to be printed in colour; we could have seen more details' – (Clare-Museums Sheffield).

The decision to change the labels and only print in white is not necessarily a statement of power nor a dislike for 3DSP, but is potentially driven by a desire to retain accuracy in the museum, for the colour accuracy of the 3D scanner is not perfect. Consequently, this results in a visual difference between the museum object and its 3DSP counterpart.

The colour of the 3DSP objects was not the only concern non curatorial members of the museum had about the use of the technology within the gallery context: there was also an apprehension about how audiences would interpret the 3D printed object details. As a result, the labels were consequently changed to reflect the processes of manufacture rather than storytelling. Consequently, this solidified the objects in the mind of audiences as objects of manufacture. This is not necessarily either a negative or a positive change, as non-curatorial members of Museums Sheffield may have used interpretation in order to make it clear to audiences what the 3DSP objects were, especially given the novelty of the object details.

Figure 18 illustrates how the interpretation of the object details was changed. The interpretation on the right-hand side provides additional object stories, in line with the theme of the exhibition, but also uses scale as a way of cementing 3DSP as a process of manufacture. Scaling and manipulating the form of objects is not part of traditional museum practice and therefore references to the practices of scaling can be seen as a move to distance the 3D printed details from the museum's ivories.

There is a dualism at play here between the desire to maintain traditional forms of practice and the wish to modernise, to align with the expectations of audiences, that seems to be at the crux of 3DSP's integration into the museum. Embedded within this dualism is the concept of retaining accuracy within the museum, a concept explored more fully in Ch.6 '3DSP Objecthood and Curatorial Practice' and Ch.7 'The Museum and the Digital.

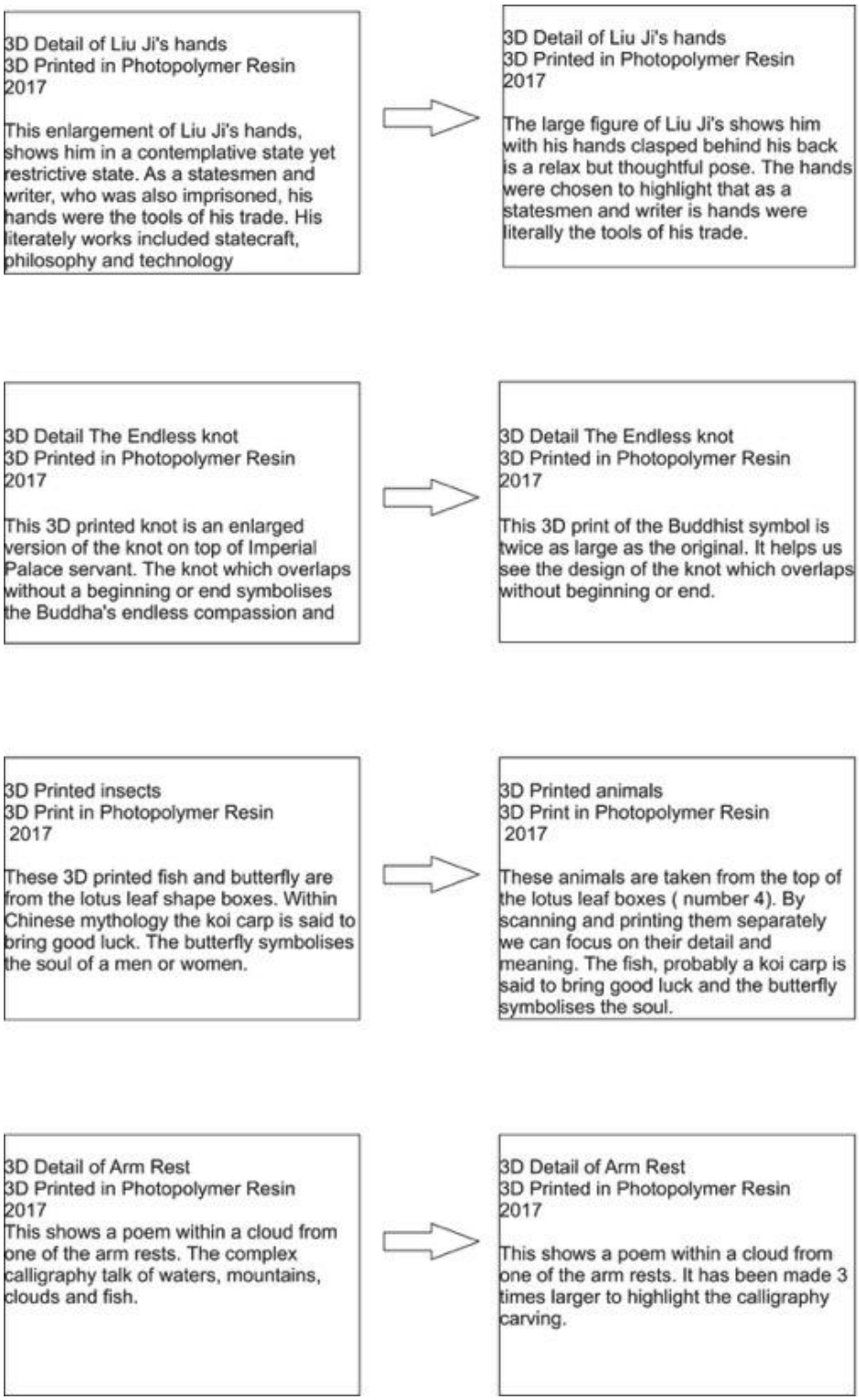
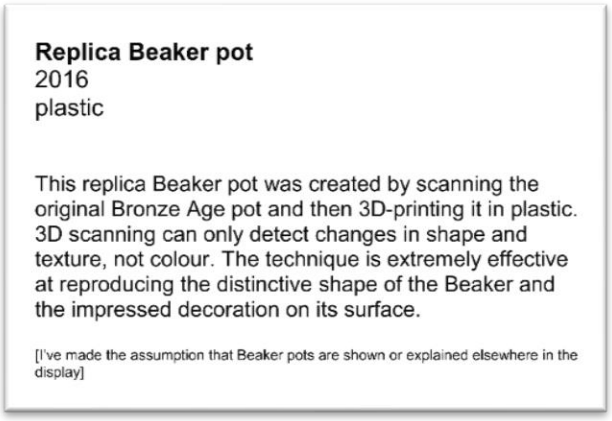


Figure 18 An illustration showing how the labels were changed for Stories from the East: The Grice Ivories

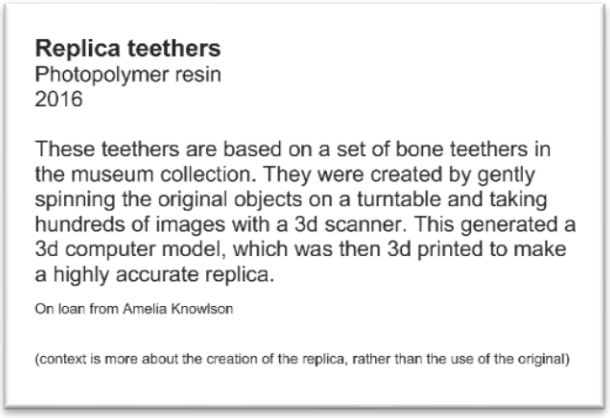
When creating the object labels as part of the residency, intervention curators struggled to define this process, commenting on whether to put 'extremely', 'highly' or 'intricately' accurate replicas, stating that they couldn't put 'almost' on their labels. This is not a reflection on their understanding of the 3D printing process, which was further complicated by how the technology lent itself to different collections and the language surrounding it, but a statement of the frameworks in which curators operated.


Replica Beaker pot
2016
plastic

This replica Beaker pot was created by scanning the original Bronze Age pot and then 3D-printing it in plastic. 3D scanning can only detect changes in shape and texture, not colour. The technique is extremely effective at reproducing the distinctive shape of the Beaker and the impressed decoration on its surface.

[I've made the assumption that Beaker pots are shown or explained elsewhere in the display]

Figure 19 Martha's response to the object label curatorial intervention


Replica teethers
Photopolymer resin
2016

These teethers are based on a set of bone teethers in the museum collection. They were created by gently spinning the original objects on a turntable and taking hundreds of images with a 3d scanner. This generated a 3d computer model, which was then 3d printed to make a highly accurate replica.

On loan from Amelia Knowlson

(context is more about the creation of the replica, rather than the use of the original)

Figure 20 Clara's response to the object label curatorial intervention

Figures 19 and 20 are Clara and Martha's response to the object label curatorial intervention. Their responses show how they also used interpretation to discuss how 3DSP museum objects had been made. The responses also allude to questions that curators had about the accuracy of the object, which is potentially due to an unfamiliarity with the processes of the technology as well as to a struggle to define 3DSP within the museum. During a scanning session at Museums Sheffield, curators commented on whether the language around the technology was a barrier to its integration:

We don't have any problem with saying a photocopy… so like 3D printer copy? I wonder if language has to catch up' (Martha- Museums Sheffield)

'We would be quite happy if it were a photocopy, cause blatantly I know what this is because we are just so used to it but we haven't quite got used to the 3D print' (Clare – Museums Sheffield).

In this instance, Museums Sheffield's curators' unfamiliarity with 3DSP could be manifesting itself as a desire to retain the accuracy of the museum both in terms of interpretation and objecthood. As Clare's comment highlights, there is still a novelty where 3DSP is concerned: everything about the object from the language curators used to describe it, to its visual properties seems to jar with the aesthetic of the museum. This is a point supported by curators from Museums Sheffield who were initially happy enough with printing the museum objects in colour, but later stated that the objects were not nice enough to go into the gallery on their own. It is a response which indicates that the materiality of 3DSP objects is not in keeping with the aesthetics of the museum. In a conversation between Martha and Clara, they discuss how they would display 3DSP museum objects stating:

I can't see a situation where I would put only the 3D scan and object out, unless as with some of the objects we have in our collection, where the object was in a different museum and the only option, we had was the 3D objects. Then you might talk about it. But then 3D scans and objects don't look nice enough to be objects in their own right, because they're plasticy (Clare – Museums Sheffield). You *wouldn't discuss the 3D object on its own in the context of the museum* (Martha- Museums Sheffield).

As a result, the measures taken by non-curatorial members of staff at Museums Sheffield to limit the display of 3DSP are to some extent supported by its curators. Museums Sheffield curators' concerns centred on displaying 3DSP objects. The visual aesthetics of the objects along with how they are interpreted in the gallery are of importance. This reveals that the decision by Museums Sheffield's senior management was in part supported by the curatorial position as there was a desire to preserve how audiences perceived the museum. It is also important to mention that the curatorial position can differ from that of the museum, as curators partaking in this study worked directly with 3DSP and thus had more of a working knowledge of the technology than those in a non-curatorial management role.

Similar frameworks were also noted at The British Museum. Prior to the residency, 3DSP was largely created by Daniel Pett, with curators having access to add interpretation and share their 3D content on Sketchfab freely. However, as this residency progressed the Information Services team became more aware of the possibilities associated with 3DSP content. There were several meetings on the metadata and version control of 3DSP content, with different departments highlighting concerns over logistics and practicalities. Upon finishing the

residency, the Information Services team decided to restrict access to the museum's SketchFab account. This move proved to be unpopular among curators, as several who participated in this research had on-going projects involving 3DSP data. My own diary writings (see figure 21) express and expand upon this decision. In them I reflect upon how cutting access impacts on curatorial practice and the development of 3DSP within the museum.

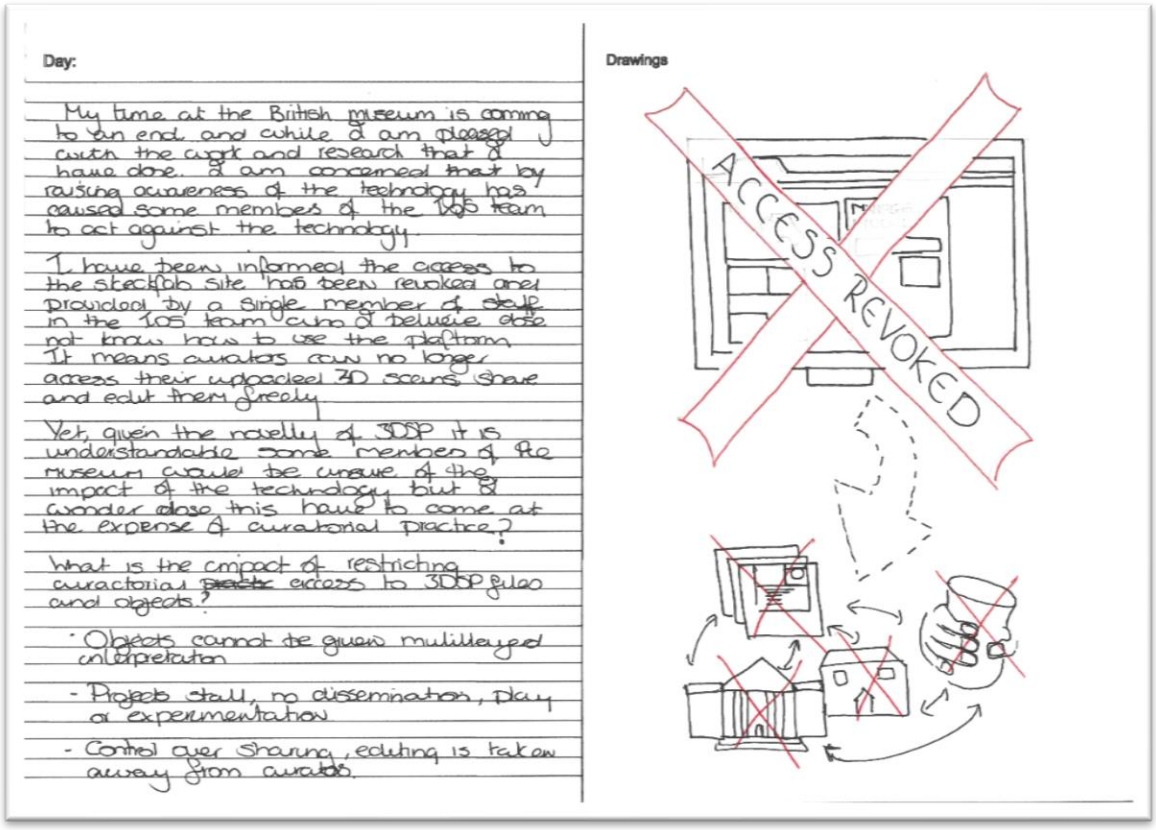


Figure 21 An example diary page from The British Museum Residency

From the above arguments it appears that the concerns surrounding 3DSP can originate from right across the museum, but seem to be voiced only by those who have not directly engaged with the technology. Here it is important to state that this is not a provocative or a negative statement but a recognition that, given the novelty and unknown aspects of 3DSP, it is understandable that curators would be cautious about integrating the technology into the gallery context. Indeed, none of the curators at either The British Museum or Museums Sheffield mention any negative effects associated with the digital or interpretational possibilities of 3DSP. In fact, one of the main values they saw in 3DSP was the affordance of sharing and disseminating data with audiences and external institutions.

This is seen in the Votive Offering project which sought to use 3DSP to explore how multiple layers of interpretation help to reveal the complexities of a polylingual stone (see practice-based submission, p.116, for an example of these complexities). In his diary writings Thomas writes about layering interpretation on the 3D scan uploaded on to Sketchfab and how the presentation and sharing of this data in this format can be beneficial to both specialists and audiences alike.

Ideally the 3D scan will be annotated with labels explaining the stone and the inscriptions and provide context integrating who found it, where, what it was found will and of course what it says. Also useful for specialist groups who work on texts. 3D scans could be a better way to present specialist work. The physical aspects of the inscription are often neglected – indeed they are often not illustrated or just present the front of the object with text. (Thomas- The British Museum).

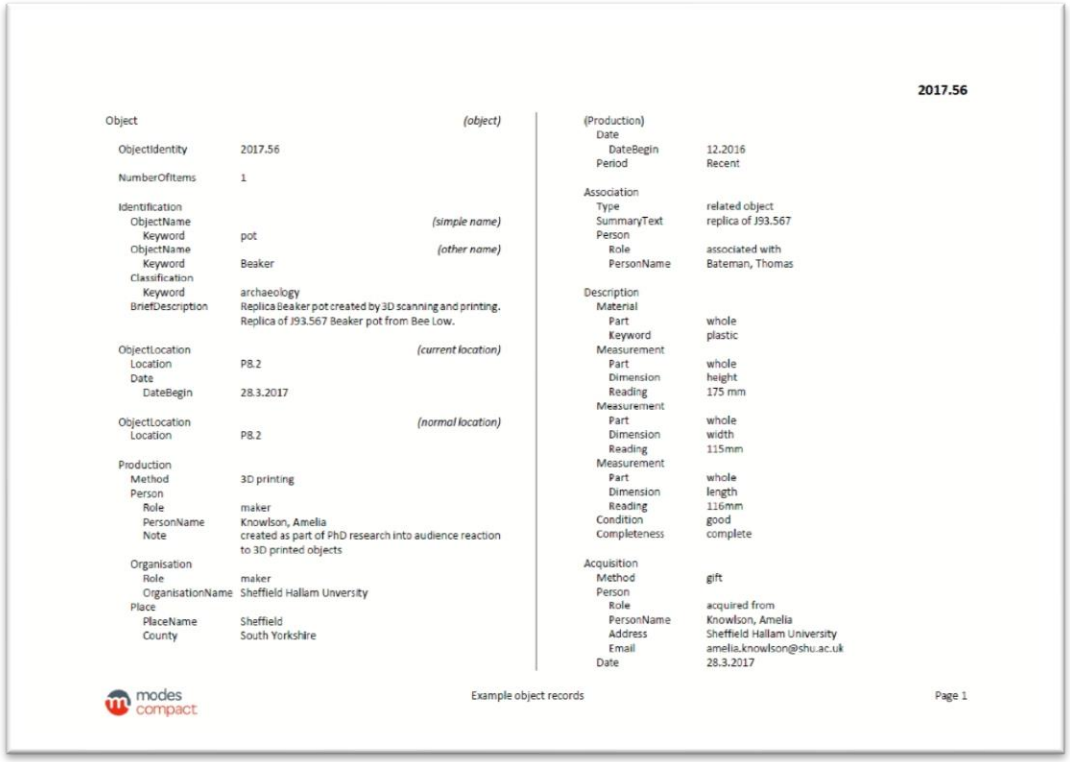
Thomas's above statement implies that current interpretational strategies of the museum fail to represent the complexities of some of its objects, especially those with ancient languages, inscriptions and carvings. Here the value 3DSP brings to the museum is evident. By engaging curators with the processes of the 3DSP, the technology's potential to enrich curatorial practice was revealed. Curators across both museums commented on how 3DSP enabled them to enhance current interpretational strategies, perceive new object insights and share their objects more freely (see Ch.6 '3DSP Objecthood and Curatorial Practice' for a more detailed discussion on these topics). Yet these developments to curatorial practice are not without their own frustrations to the culture and traditions of the museum.

5.5 Frustrating the institution

As alluded to above, the integration of 3DSP caused frustrations to the practices of the museum. These include, but are not limited to, the display and framing of contemporary replicas as museum objects, defining 3DSP through the loans systems and the time it takes to create 3DSP objects. See Ch.6 '3DSP Objecthood and Curatorial Practice' and Ch.7 'The Museum and the Digital' for an in-depth examination of the above.

The accessioning task of the Museums Sheffield curatorial interventions revealed how bringing the 3DSP object into the collection of the museum was a frustration to the traditional practices of the museum. Curators responded to the intervention by using the term 'gift' to

denote how the 3DSP object came into the museum (see practice-based submission pp.39-40 and figure 22).



2017.56

Object		*(object)*
ObjectIdentity	2017.56	
NumberOfItems	1	
Identification		
ObjectName		*(simple name)*
Keyword	pot	
ObjectName		*(other name)*
Keyword	Beaker	
Classification		
Keyword	archaeology	
BriefDescription	Replica Beaker pot created by 3D scanning and printing. Replica of J93.567 Beaker pot from Bee Low.	
ObjectLocation		*(current location)*
Location	P8.2	
Date		
DateBegin	28.3.2017	
ObjectLocation		*(normal location)*
Location	P8.2	
Production		
Method	3D printing	
Person		
Role	maker	
PersonName	Knowlson, Amelia	
Note	created as part of PhD research into audience reaction to 3D printed objects	
Organisation		
Role	maker	
OrganisationName	Sheffield Hallam University	
Place		
PlaceName	Sheffield	
County	South Yorkshire	

(Production)		
Date		
DateBegin	12.2016	
Period	Recent	
Association		
Type	related object	
SummaryText	replica of J93.567	
Person		
Role	associated with	
PersonName	Bateman, Thomas	
Description		
Material		
Part	whole	
Keyword	plastic	
Measurement		
Part	whole	
Dimension	height	
Reading	175 mm	
Measurement		
Part	whole	
Dimension	width	
Reading	115mm	
Measurement		
Part	whole	
Dimension	length	
Reading	116mm	
Condition	good	
Completeness	complete	
Acquisition		
Method	gift	
Person		
Role	acquired from	
PersonName	Knowlson, Amelia	
Address	Sheffield Hallam University	
Email	amelia.knowlson@shu.ac.uk	
Date	28.3.2017	

modes compact

Example object records

Page 1

Figure 22 Martha's accession Record

The accessioning process only allows for limited terms such as ‘gift’, ‘loan’ and ‘purchase’ and, as such, the use of the label ‘gift’ implies certain notions of value. For example, it reveals that the museum does not want to spend money on 3DSP objects, as well as not actually seeking the object through a bequest. The use of the term signifies that the museum has been given the 3DSP object without actually requesting it.

For decades the museum has been one of the most prestigious and authoritative places for seeing and learning about original works of art. This authority comes not just from subject expertise on collections but also from the power to order, catalogue and determine object taxonomies. The authority of the museum can be seen to be frustrated by the introduction of objects that do not comply with the museum’s collection policy or that struggle to be defined within the museum’s framework. This is seen both in the arguments outlined in the sections above and in the accessioning task. For a complete list of the accessing task, see the practice-based submission pp.39-40. The frustration of museum practice, especially in terms of

bringing 3DSP objects into the collection was also noted at The British Museum. John used his curatorial interventions to question what would happen if 3DSP objects were to be accessioned into a current collection and asked how this would affect how audiences and curators would use them.

'Should prints go into the printing collection? If they do it can change how they are used, e.g. not allowed to be handled by audiences' (John – The British Museum).

It can be argued, therefore, that the complex interactions and negotiations within social, economic, political and cultural contexts are potentially the reason why 3D technology has yet to find a permanent place within the museum. This statement is supported by Keene (2006) who asserts that the growing importance of the virtual in our world creates an issue for the museum that is becoming ever more impossible to ignore.

For the museum, the act of collecting and displaying digital works raises queries about authenticity, both in terms of the works in question and in the response of the museum. This is a concept raised by both Julia and John. The former created a drawing for her 'Curators Box', which explored the role and the place of 3DSP in the museum (see figure 23). In the top right-hand corner of her drawing, Julia *writes 'Do many 'versions' dilute the uniqueness of the 'original'?'* Her question is ultimately the same as John's, who, in his curatorial interventions, wrote:

'By replicating are we damaging the value of the original? i.e. if something can be copied perfectly how many times can we do this before the potency of the original diminishes' (John -The British Museum).

The idea that the 3DSP replica might damage the potency of the museum object implies a perceived relationship between the two objects, as well as raising questions about the collection of 3DSP objects. This perceived relationship was noted among Museums Sheffield curators who, in cross-curatorial conversations, spoke of how 3DSP did not make them think differently about the museum version: '*it was familial rather than emotional' (*Clare-Museums Sheffield).

A 'familial' relationship is harder to integrate into the cataloguing system of the museum and is further evidence of how 3DSP objects challenge the structure of the museum. It raises

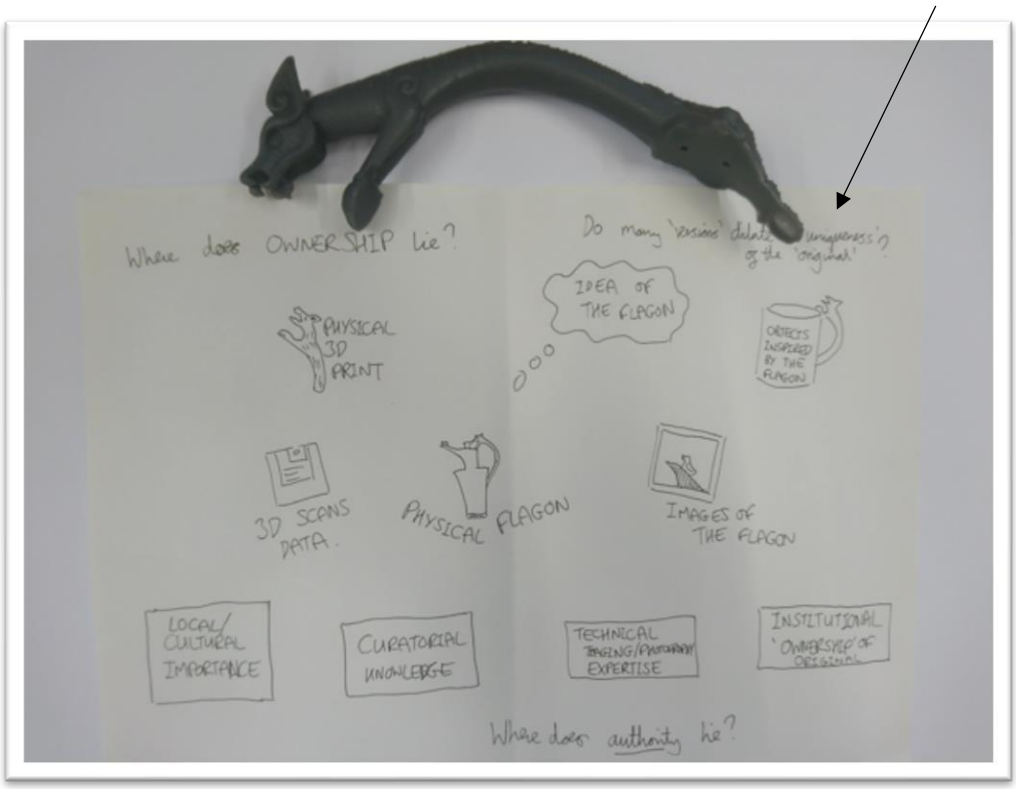


Figure 23 A drawing by Julia exploring the role of 3DSP in the museum

questions about how to document object relationships between contemporary and historical objects, especially when the relationship is born from mechanical means. A potential consequence of the integration of 3DSP is the need to update the categorising systems of the museum.

However, even without the perceived problem of bringing 3DSP objects into the collection of the museum, the technology was still perceived as representing a frustration to the museum, through the struggle to define what 3DSP objects were. For example, The Basse-Yutz project undertaken with Julia at The British Museum revealed the museum's concern to secure rights to 3D data and to control its dissemination, even when the data is beyond the legislative control of the museum. Members of the museum's legal team were concerned about how external institutions would use or manipulate the data (see Julia's diary extract, figure 15). The museum sought to secure copyright over 3D data and content in order to determine how the data could be used.

There is no precedent for loaning 3D scans and or prints. The 3D models used were not part of the collection and could be used and edited in ways that a traditional image or object could not. The result was that the 3D scan did not comply with standard object-based practices. In order to arrange a digital loan of 3D scans the museum had to consider factors like the manipulation of the objects, Creative Commons Licenses, access within the museum, software licenses and reproducibility.

Here, it seems the novelty of 3DSP objects causes frustration within the current practices of the museum. 3DSP objects fall between current categorising taxonomies. They are simultaneously an object, a digital work, related to the collection, able to be edited and they struggle to be defined under current copyright law. This contrast to current museum taxonomies is noted by Neil who, in his curatorial intervention, wrote: *'there is a novelty/contrast with 3D and the museum',* a statement supported by Janes (1997) who writes that, at the heart of museological innovation is the need to reconcile what has always been seen as opposites: tradition and technology. The complex nature of 3DSP objects, combined with objects recent introduction into the museum, means that both curators and those in non-curatorial roles are naturally cautious about the impact that 3DSP could have on museum practice.

Yet there is also an un-institutionalising effect at play. 3DSP objects are not simply being rejected from the museum, but their presence and their role within the museum are being questioned by curators. This implies breaking away, potentially subconsciously, from the categorising and ordering effect of the museum. The values of hierarchy, aesthetics and judgments are being unpicked by curators, who question where and how 3DSP sits within the museum.

'scanning is the sharing of objects. And I had hoped the 3D prints and scans could cross a divide that the museum objects could not and allow me and the museum to collaborate with external colleagues in a new way. However, the complexities of the unfamiliar seem to have compromised this somewhat' (Julia - The British Museum)

Julia's comment highlights how the unfamiliar challenges of 3DSP can cause its potential to disseminate, share and enrich engagement to become restricted. Working on the Basse- Yurtz project with Julia allowed me to observe these restrictions in practice. I watched as people

repeatedly questioned whether the light of the scanner would damage the flagons. I listened as members of the museum questioned the Copyright, Creative Commons License and layers of assigned rights. I sat in meetings about the metadata, reproducibility and storage of 3D data files. It is important to mention that these are not negative observations but a recognition that the unknown can frustrate current practices of work and can cause the institution to be especially wary of the short and long terms implications of this new tool. The above argument highlights the legal concerns over 3DSP, yet it is also a statement of how the museum seeks to ascertain how 3DSP could work within the museum.

5.6 The D.I.Y curator

While the unfamiliarity of 3DSP challenged museum policies and preconceptions on objecthood in other areas, it was also seen as an enrichment. During the Acclimatisation Study and both residencies, curators were asked to engage physically with the 3D scanning process, consequently creating a new form of curatorial practice: one where the curator is part of the making process.

This new form of curatorial practice was especially prevalent among curators at Museums Sheffield who did not have a digital team to support digital endeavours, consequently giving rise to the 'do it yourself' curator. During scanning sessions at Museums Sheffield, curators selected, watched and scanned their objects (see figures 24 and 25). Their comments with regard to 3D scanning the objects reflected the making process.

It's like watching an object come into existence' (Leighanne – Museums Sheffield)

'Wow! It's like magic' (Clara – Museums Sheffield)

'It's like a whole new object' (Alister – Museums Sheffield)

'It's like an intangible form of tracing' (Leighanne – Museum Sheffield)

The curator's comments refer to the idea of bringing an object into existence, much like a potter would do on a potting wheel. Yet while curators transform objects into 'museum objects', they do not make objects for the museum. The idea of curatorial making is new to the role of the curators and has been brought about by the introduction of 3DSP. Here, it is important to reiterate that any scanning, done by either myself or the curators, formed part

of a research process that aimed at understanding the curatorial perspective and not creating a prefect scan.

During the Acclimatisation Study, curators become interested in the capabilities of the scanner, not only from a technological perspective but from a position of learning. They were keen to watch me scan and see the 3D scanned data points accumulating on the screen in real time. Curators' comments were framed around the creation of 3D scanned objects. This had the potential to challenge traditional notions of curation since, even within the accessioning process, there was no label/signifier for an object created in house or by members of staff. As each of the curators become more involved in the acclimatisation study, their attitudes towards 3D scanning technology changed.

Figure 24 Naomi watches me 3D scan the Cornell Cael Bell Cover

Figure 25 Leighanne 3D scanning an antler bone

During the Acclimatisation Study, Museums Sheffield curators began to recognise that certain object properties were extremely difficult to scan and they questioned how similar properties could be captured. Industry standards recognise that glass is extremely difficult to scan, and to an extent, there are guidelines in place to help. However, no such framework exists for reflective and iridescent surfaces such as crystal, glass and silver which are often only found

together in the museum. The curators questioned if the scanners would be able to 3D scan mother of pearl and iridescent feathers. Here 3DSP has become an object of curiosity and exploration rather than just a process of wonder. It has the capacity to create new objects and encourage curators to examine their collections in closer and more refined detail.

The traditional notion of the museum often negates these complex sensory interactions from ever taking place. The 'origin of museums as temples to reason means that a key aim has been to tame objects and diminish their power' (O'Neill 2006: 101). This is an argument which is supported by Hackner (2005), who uses the glass case as an allegory for the 'do not touch' rules within the museum. The use of scanners as a means of exposing curators to the formal processes of 3D technology breaks down these barriers, even within curatorial frameworks.

In current practice, objects are accessioned, linked to other objects within the confines of the museum's collection policy and placed in the store. However, the use of 3D scanners and the time taken to explore critically each object, its process and its meaning, allowed curators to engage with the 3D objects, not just on a material informational level, but through heightened and more creative spatial, temporal and perceptual modalities.

5.7 Conclusion

The curatorial position on the integration of 3DSP is not easily defined and can shift, depending on the context in which the technology is presented. Yet, the frustrations to practice and possibly even to tradition come when 3DSP museum objects need to become part of the museums' legal collection or daily operational system. Curators disagreed with how 3DSP was controlled, whether this was in the way that the objects were displayed or whether it was concerned with the Intellectual Property Rights surrounding such objects. This implies that the perception of 3DSP, its role and its position within the museum, can be altered following a more engaged experience with 3DSP. It is acknowledged that this is more likely to happen at regional and smaller museums, where digital departments and expertise are sparse, but the desire to engage with this technology is present across curators, regardless of the museum in which the technology is situated.

The three studies revealed that those who were not working directly with 3DSP appeared to raise the most concerns about its use and its integration within the museum. As a

consequence, it can be argued that the methods of this study, engaging curators with the processes of 3DSP, helped to alleviate some of these concerns.

While the integration of 3DSP cannot be easily defined, how curators perceive the use of 3DSP within the museum can. Curators at The British Museum and Museums Sheffield saw 3DSP as a way of supporting audience engagement, curatorial enrichment and the dissemination of objects. These developments to museum practice have come about because 3DSP is not seen as being part of the core museum collection. The material and perceived value of 3DSP separates it from the museum's actual objects. As a result, the use of 3DSP within the museum is not completely restricted by the frameworks and the systems that dictate the operations of the museum. 3DSP frustrates these systems and causes new forms of curatorial practice to emerge.

6. 3DSP Objecthood and Curatorial Practice

6.1 Introduction

The research outlined in this chapter seeks to reveal the changes, frustrations and enrichments that 3DSP has brought to curatorial practice. Embedded within this discussion are insights, challenges and frustrations concerning authenticity and authority, objecthood and the potential for new forms of curatorial museum practice. It draws particularly on the curatorial interventions and my own diary writings to present and examine the impact that 3DSP has on the practicalities and the traditions of curatorial practice.

The chapter first explores the perceived authenticity and authority of 3DSP museum objects particularly in relation to the aesthetic and material properties of the object. The chapter then goes on to explore the notion of using 3DSP objects to play with collections and how this can create new forms of curatorial practice. After this, it examines how curators perceived new object and institutional insights by using and engaging with 3DSP technology. The penultimate section of this chapter is an examination of how curators wished to play with 3DSP to re-actualise objects and bring the lifehood of objects back to the forefront of the museum. Finally, the chapter concludes with a musing on how the lack of policies and structure surrounding 3DSP can help to facilitate the forms of play discussed above. Yet at the same time the section posits that the museum could be acting as a form of earthly purgatory, as it does not offer 3DSP objects the same protection as museum objects.

6.2 Authenticity, authority and the replica

As mentioned in Ch.1 ‘The Introduction’, the authenticity of replicas in the museum has had a rather chequered past for, behind their creation, circulation and use lies a series of specific social relationships and networks that define why, when and in what circumstances they are valued or not (Foster and Curtis 2016). In contemporary museology, age, patina and material decay are important defining experiences in the creation of ‘pastness’ (Douglas-Jones et al. 2016) and the term ‘genuine’ and ‘real’ have come to be associated with the concept of authenticity (Pye 2001). Thus, establishing a link between age and authenticity within the museum and offering a reason why curators perceived a difference between museum objects and their 3DSP counterparts.

'the 3D scans and objects don't look nice enough to be objects in their own right, because they're plastic'' (Clare – Museum Sheffield).

'the vaguely cheap feeling plastic does not make it feel authentic. I don't know why: it's the weight, it's the look of the material' (Leighanne- Museums Sheffield).

Comments from curators at Museums Sheffield focused on the contemporary materials used to produce 3DSP objects. Clare's comment about the 3DSP object not being 'nice enough to be a real object' is both a statement of the age of the object and its physical qualities as defining characteristics of its 'un-museumness'. Yet in practice, neither an object's beauty nor its age are factors in the accessioning process. One has only to look at the well-loved children's toys among social history collections across the county for evidence of this. However, this is not the case for 3DSP objects, whose physical properties seem to act against their immaterial ones, limiting the objects' progression into the framework of the museum.

The visual appearance and the aesthetics of manufacture of 3DSP objects can be considered one of the core reasons why curators at both museums have struggled to attach authenticity to 3DSP museum objects. It is important to mention that there was no preconceived desire for curators to attach a sense of authenticity. The concept of authenticity and authority emerged from the curators' questioning the role 3DSP had in the museum. Curators across both museums were concerned with the contemporary nature of the materials used to create 3D printed objects and the mechanical means of production. When examining the flow charts completed by British Museum curators (see figure 10 in Ch.5 'The Curatorial Intention' and pp.93-96 in the practice-based submission) 5 out of 8 said they would not scale their 3D object up or down, stating that they wanted to preserve the authenticity of the object. This implies that The British Museum curators saw a link between the 3D print's physical qualities (particularly one of scale) and the authenticity of the original, consequently signifying a perceived relationship between the two objects. This perceived relationship is explored in more detail but from different perspectives in Ch.5 'The Curatorial Intention' and Ch.7 'Museum and The Digital'.

Only one curator, Neil, said he would change the scale of his printed object. He wrote that the reason behind this was '*handling and printer costs*.' While the reduction in size to minimise printing costs is evident, the idea of reducing the size for handling is perhaps

embedded in the idea of protection. For example, by making the 3D printed Mould Gold cape smaller, fewer visitors would be able to try it on and thus potentially increase its life as a museum handling object. This point was also explored by Alister from Museums Sheffield who, upon finishing his exhibition concept, wrote that handling might be seen as a form of protection (see figure 26). In essence, he is implying that by allowing audiences to handle some objects, those which are unlikely to be damaged from tactile interaction, visitors are less likely to be tempted to touch objects in the main collection. However, these were the only two curators, out of all 11 participating, to mention scale and handling in this way.

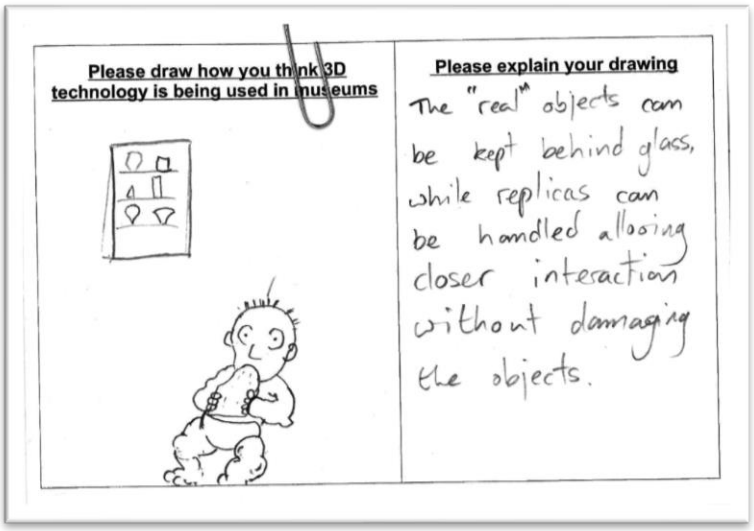


Figure 26 A close up of Alister's exhibition concept showing how he would use 3DSP

The remaining participating curators perceived 3DSP as a tool for increasing object understanding and engagement both for themselves and for audiences. For example, the idea of creating 3D printed robotic trilobites was used by Alister to help audiences understand how the actual creatures moved. Furthermore, Martha posited the idea of creating a live accessioning and 3D scanning platform in her exhibition concept (see practice-based submission p.53) to allow audiences to see more of the 'behind the scenes' of curation.

Yet, at the same time, neither museum was keen to truly incorporate 3DSP into the core collection and practice of the museum. Curators at Museums Sheffield did not want to accession 3DSP objects and curators at The British Museum had concerns over the storage logistics of 3DSP data. Figure 27 is an example page from my Museums Sheffield diary and documents my own musings about why museums would not want 3DSP objects to be part of the core collection.

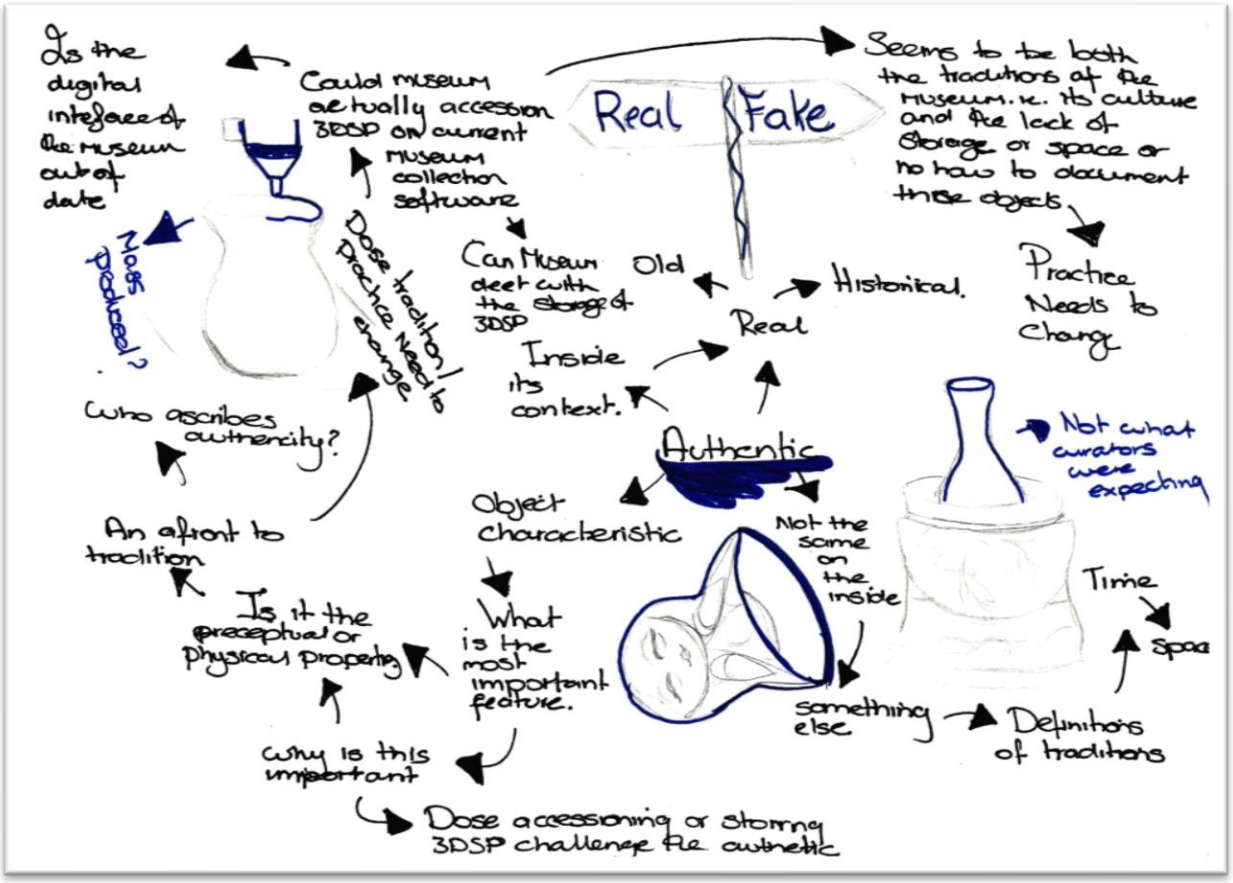


Figure 27 An extract from my Museums Sheffield diary showing musing about the authenticity of 3DSP

I reflect upon what it is to be authentic in the museum environment, and muse upon whether the ascription of authenticity has to do with the object's physical properties and/or with the traditions of the museum. I conclude that museums do not want to document or store 3DSP objects because their systems, practices and traditions are not set up to deal with contemporary manufactured replicas made by mechanical means. For a more in-depth discussion regarding the documentation and the storage of 3DSP datasets see Ch.7 'The Museum and the Digital'.

In general, museum curators had concerns about how audiences would perceive the 3DSP within the gallery context. Both Leighanne and John (despite being from different museums and curatorial backgrounds) expressed this concern in their separate curatorial interventions in which they stated:

'It doesn't [3D printed museum objects] seem like something people would want to see in an exhibition. (Leighanne- Museums Sheffield).

'Does this object [3D scan and print] take way from the original?'- (John -The British Museum).

Leighanne's and John's comments work in conjunction with my initial musings, written while I was at Museums Sheffield, in that the reason why curators do not want 3DSP objects to be part of their core collection is both to due the objects', physical and digital materiality and to the culture of the museum. Yet this is not necessarily surprising given the combative relationship between the museum and the replica.

The replica has long had a contentious relationship with the museum, as explored in Ch.2 '3DSP in Context and Practice: A Contextual Review' and, as such, the introduction of 3DSP, even with its apparent benefits, is unlikely to change how the replica is perceived. Although curators from Museums Sheffield recognised a perceptual difference between the historical replica and the replicas created by 3DSP; that being that the value of 3D data being derived from the museum object. In a conversation between Martha, Clara, Alister and myself, they commented on how they saw the value or uniqueness of 3DSP objects.

'I think what I thought about using 3D scanning and printing is that instead of it being the same replica you can see in 100 museums across the country it's an actual scan over' (Martha- Museums Sheffield).

'You could copy what that thing is; it's more than just buying a generic dollhouse that anyone could recreate. What's unique about the 3D dolls house is it comes from the collection' (Clara- Museums Sheffield).

'It's unique but it doesn't need to be' (Alister- Museums Sheffield).

This conversation induced me to consider what it was that made 3DSP unique and what made curators want to engage with the technology, especially given the concerns mentioned above. The perceived relationship between the scan data and the museum collection signifies a difference between historical replicas and 3DSP replicas. It implies that there is a perceptual relationship between the museum object and its 3DSP counterpart, that differentiates 3DSP objects from historical museum replica and causes curators to want to engage with the technology.

The visualisation of this relationship was a key fact for curators at both Museums Sheffield and The British Museum in deciding whether or not they would display 3DSP museum objects

in the gallery. Curators at Museums Sheffield commented on how they could not envisage a situation where 3D printed objects would be put on display without the originals or context, while all participating curators at the British Museum wrote that they would add interpretation to 3D scans displayed online and in a gallery context.

An example of such interpretation in addition to the Votive Offering Project explored in Ch.5 'The Curatorial Intention', is the Luzira Head project undertaken at The British Museum alongside John Giblin. John sought to use 3DSP to create a multi-layered interpretation to illustrate multiple object facts, whilst also demonstrating the relationship between the 3D scan and the museum object. The 3D scan on Sketchfab (see figure 28) includes navigable information points that detail important information about the object, while an explanation about the scan's origin and method of production exists below. The Luzira Head project is an example of how 3D scanning museum objects and sharing them online adds value to the museum's digital offering. The museum is able to use 3D data not only to share objects and support external projects but also to create a multi-layered story that was not possible with traditional in-gallery interpretation layouts and methods.

Figure 28 A 3D scan of The Luzira head with multiple interpretation points

The combined value of sharing objects, enhancing the interpretational outputs of the museum and a perceived return of physicality, meant that curators were unfazed by the introduction of 3DSP - provided that 3DSP objects did not become part of the core collection. This is explored in more detail in Ch.7 'The Museum and The Digital'. Curators from across the two museums commented on the prospects of making and handling. In their curatorial interventions, they wrote:

'I suppose making a new thing by 3D scanning and printing an object you're kinda making a ghost of the object' (Martha- Museums Sheffield).

'People are excited by the new technology and possibilities and especially enjoy being able to touch and handle objects and scans' (Julia- British Museum).

'3D scans give much greater depth and experience of the object and audience in the round' (John -British Museum).

John's comments refer to the idea of remote online audiences being able to move, rotate and closely examine uploaded 3D scans. The ability to experience an online 3D object in the round would provide a far more engaging experience than observing an online photograph, a concept explored in more detail in the section below, 'Playing with Collections'.

The idea of making and providing new possibilities within the collection allows curators to examine objects through digital forms of interaction, for example, twisting, zooming in on and segmenting 3D scans. As explored in my own diary pages, these behaviours allow for a new form of curatorial practice that is not normally seen in historical museum curation and this is potentially because 3DSP sits outside of the hierarchal frameworks of the museum.

Yet these new forms of practice are not without contention. The 3D objects' perceived uniqueness and relationship to the collection object are all concerns that curators have about the integration of 3DSP within the museum. Such concerns are rooted in museological traditions and play into the idea of museums as tools for preservation. 3DSP can thus be seen as a technology that challenges the traditions of the museums, allowing curators to work with complex forms of interpretation and more robust forms of physical interactions. It even brings the making of objects into the role of the curator.

6.3 Playing with Collections

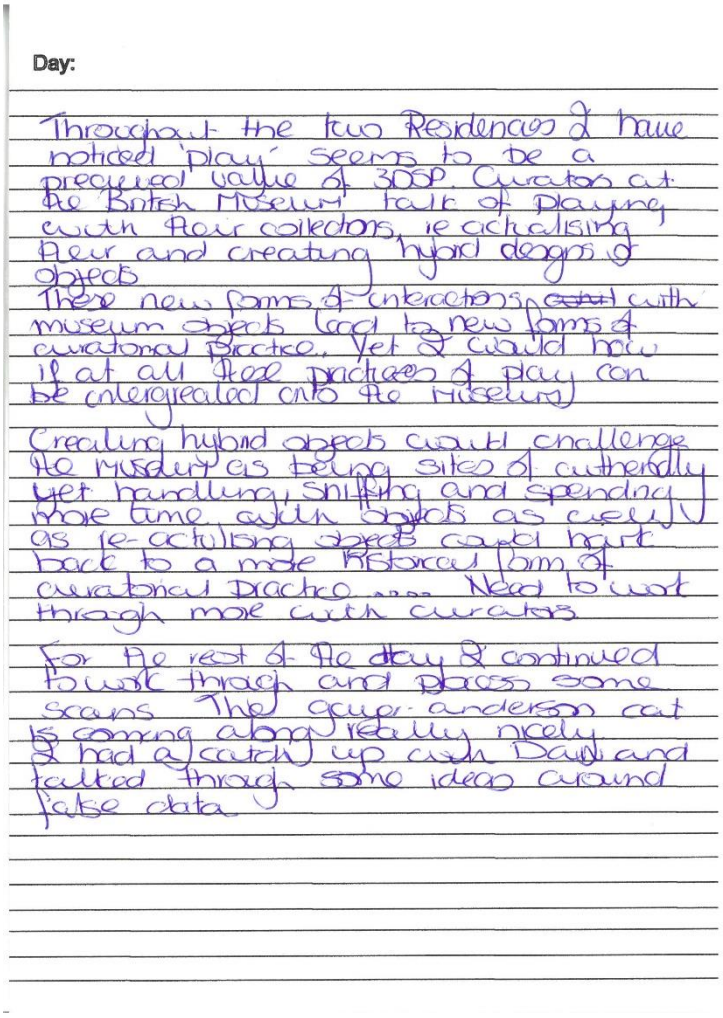
3DSP was seen as a way of playing and experimenting with collections. Curators were keen to use 3DSP to re-actualise their objects, and even to create 'hybrid' objects. This is despite concerns about how far the possibilities of 3DSP would go, especially in relation to ethical considerations and where new objects would sit within the museum. The re-actualisation and hybridisation of museum objects, even digital museum objects, has the potential to create new forms of curatorial museological practice. Replica objects that are exact copies in terms

of form are used to understand the original better and can even reconstruct or even rework the design of museum objects. Neil and Neal write about playing with collections in their audience questions task as part of their curatorial interventions:

…'the potential in 3D printing to produce more 'hybrid'- like objects that rework/spinoff the design/aesthetic of the original in a creative and playful way' (Neil -The British Museum).

'The real value of 3D scans is beyond the gallery online. Especially allowing audiences to see, explore, manipulate 'their objects' (Neal -The British Museum).

The idea of hybrid museum objects or of allowing audiences to manipulate digital museum artefacts is a practice that is new to museums in that it challenges the historical concepts and the practices of the museum. This is not to say that play does not feature in the museum (see, Beale 2011 or Simon 2010); indeed, Falk and Dierking (2000) argue that play can be a form of 'free-choice learning'. Yet play is usually marketed to audiences in the form of participation activities and not museum curators who, despite handling objects on a day to day basis, do not tend to use digital technology to create new forms, versions or artistic spinoffs of museum objects. Figure 29 is from my British Museum diary and explores the concept of curatorial play. In it, I consider what curatorial play may be.


Day:

Throughout the two Residencies I have noticed 'play' seems to be a prequel value of 3DSP. Curators at the British Museum talk of playing with their collections, ie actualising their and creating hybrid designs of objects

There new forms of interactions ~~with~~ with museum objects lead to new forms of curatorial practice. Yet I would how if at all these practices of play can be intergrealed onto the Museum

Creating hybrid objects would challenge the museum as being sites of authority yet handling, sniffing and spending more time with objects as well as re-actulising objects could hark back to a more historical form of curatorial practice..... Need to work through more with curators

For the rest of the day I continued to work through and process some scans The Guy Anderson cat is coming along really nicely I had a catch up with David and talked through some ideas around false data

Figure 29 An example diary page showing my musings over curatorial play

What is innovative here is that 3DSP provides opportunities for curators to play with their collections physically, augmenting and manipulating their objects' form and even their structure. It implies that, despite concerns about authenticity, authority, materiality and aesthetics, the opportunity to use 3DSP to enliven curatorial working life, restore creativity and physically engage with the collection in a new and potentially more robust way, is far more important to curators. The positive ramifications of playing with collections can extend to supporting audience engagement, participation through handling, inclusion within the museum's educational offering and audience-led content.

Using 3DSP to play with museum objects extended beyond the physical to include manipulating 3D scanned museum objects in visualisation platforms such as Sketchfab.

Curators at The British Museum noted that play gave the 3D scans and printed objects a sense of intimacy or physicality. They commented on how actions of zooming in or twisting the object on screen made it feel more personal. When speaking about the 3D scan of the Votive Offering, Thomas commented on how the ability to move the 3D scan across multiple planes made the object feel near to him.

'It feels intimate… being able to move and rotate the object makes It feel like it is actually there' (Thomas – The British Museum).

Furthermore, in Alexandra's curatorial interventions, she wrote about how the 3D scan can give a complete representation of the objects, contrasting with the fact that curators have to rely on the second-hand images which miss details. In her audience questions task as part of her curatorial interventions, she writes,

'3D scans also useful for scholars as they give a complete representation of the object. It makes them seem more physical. It also does away with that annoying problem of realising that the detail you need to see is not covered by the images available especially 'minor' details like sides or under sides of objects'' (Alexandra- The British Museum).

The idea of physical actions supporting a perceived physicality in the 3D scans is a new development and has not been documented in current 3DSP museum literature. Yet, as Borun (2002: 223) states, 'direct interaction with objects allows for visual and kinaesthetic learning that can be far richer and more complex than text alone'. As such, it can be argued that the opening up of the 3DSP process, as noted in Ch.3 'Method', and the facilitating of curatorial play with 3DSP objects can support curatorial object-based learning.

By physically engaging with 3DSP objects, curators, especially those from The British Museum, noticed that viewing a digital museum object in multiple planes was far superior to their current method of using photographs. This is a statement that is supported by Alexandra's comment above and by the comments from other curators at The British Museum in that it highlights how 3DSP does have a desired place in the museum and how curators recognise the limitations of photographs.

'My thoughts on seeing Amelia's scan of the Ringlemere Cup: - Just how 3-dimsensional this object is and how poorly (by comparison) photographs capture the complexities of the cup's form, decoration and damage'. (Neil – The British Museum).

'3D scans: most of our audience engage with object through our online platform where they only receive a 2D image if they are lucky. – 3D scans give much greater depth and experience of the object and audience in the round' (John – The British Museum).

'…. Traditionally we use 2D drawings/photos or paper moulds (squeezes) but 3D scans could be a better way to present specialist work. The scan is a good talking point/ conversation piece. – you can interact with it and ask it questions much better than a static display, that often doesn't include enough info to understand the object. The museum is very bad at bridging the public with the broader practice. Modern interpretation is simplistic and reductionist and very patronising. – Digital displays allow us to layer all of the interpretation' (Thomas – The British Museum).

The quotes above show that curators at The British Museum see a connection between the photograph and 3D scans. At present, museums use photographs to document, observe and visualise the objects. The introduction of 3D scans can be seen to replace at some point the use of photographs for, according to curators, they capture the complexities and give a greater depth of experience than the 2D image.

Furthermore, Thomas's comment exposes how the curatorial processes or 'the backstage' practices of the museum are not shown. The exhibition is the presented outcome with the thought processes and decisions hidden. Thomas argues for the importance of allowing visitors to see the processes of the museum so that they can understand how the museum object is 'produced' and is not merely the words on the interpretation label. The introduction of 3DSP cannot solve the problems associated with modern museum interpretation, but it can help to reveal the complexities and the polysemy of objects through digital interaction and provide a more complete online viewing experience.

As such, using 3DSP to play with collections has the potential to challenge interpretational practices and policies of the museum, changing the way audiences and curators experience the museum's online collection.

New ways of experiencing the online collection were explored in the exhibition ‘Frustrating the Linear’ (see figures 30 and 31). The exhibition was a performance piece that sought to reveal, through a single museum object (The Ringlemere Cup), the structures of the museum archive. The work consisted of hanging 2D images, data records and photographs and 3D prints collected from the museum’s E-collection. Over three days, the work was hung multiple times to reveal and reflect upon how the often-hidden curatorial decision processes and categorising systems affected how museum objects were perceived.

Figure 30 A photograph showing a curatorial desk in progress from the exhibition 'Frustrating the Linear'

The exhibition sought to challenge the linear and highly categorised nature of the museum database which, as explored in Ch.7 ‘The Museum and The Digital’, creates artificial hierarchies and values in collected object information. By visualising and loosening the structures of a museum’s archive, new object relationships and insights could be revealed.

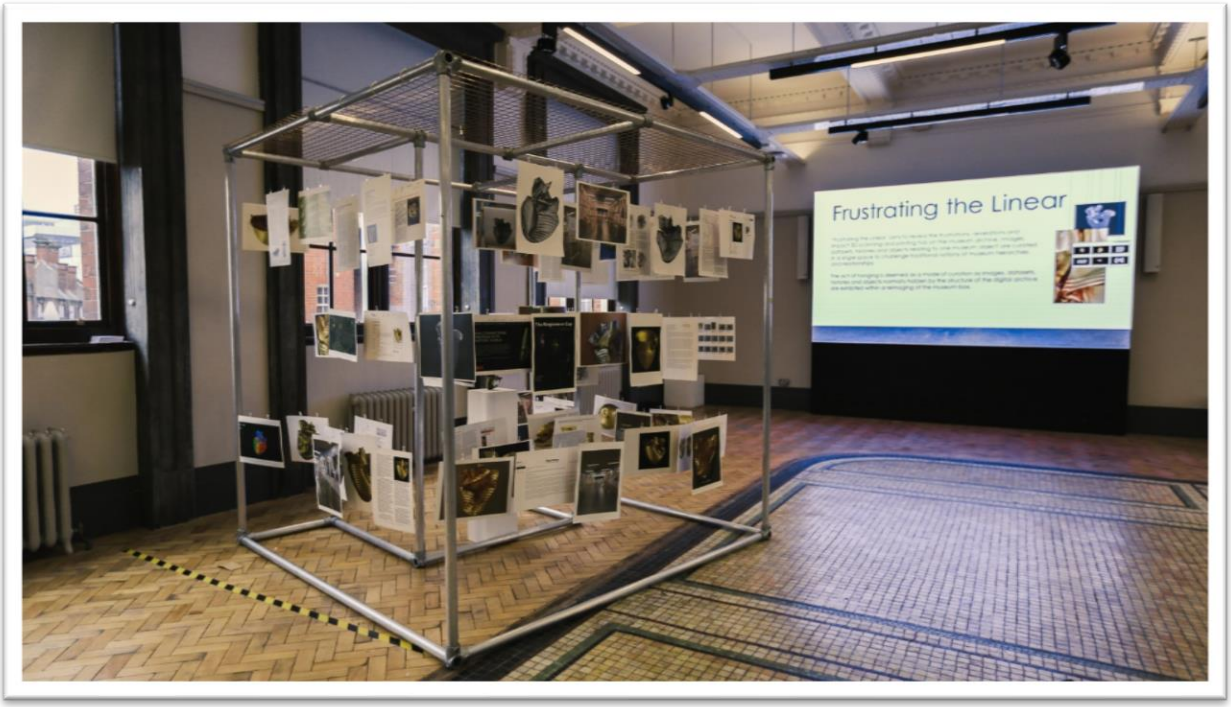


Figure 31 A photograph showing the 'archive' from the exhibition 'Frustrating the Linear'

Breaking the linear nature of the museum was first mentioned by Neil who, in the quote below, alluded to how play can facilitate a loosening in the structures of the institution and consequently enable new behaviours to emerge.

3D as a form of free play… that breaks the linear nature of the museum (Neil -The British Museum)

New curator-object behaviours were also noted at Museums Sheffield, where Clare would smell the 3D printed Bronze-age Burial Pot that I brought into the museum (see figure 31). In general, curators do not tend to smell objects but perhaps the lack of any rules prohibiting it, together with not being fearful of handling 3DSP objects, plus the fact that the 3DSP object had no significant smell, triggered this response. In this sense, using 3DSP to play with collections can facilitate new behaviours by allowing curators to operate outside the museum's normal policies and practices.

Figure 32 A photograph showing Clare smelling a 3D printed Bronze-age Pot

Neil's comment and Clare's new curator-object behaviour highlights how actual museum objects move through the museum and become institutionalised. The complex relationships, lives and stories associated with these objects become condensed and eventually reduced. This is a point supported by Thomas (see p.99). The same reductionist practice does not occur with 3DSP objects, as they are free from the structures of the museum. They are not accessioned; nor are they covered by museum policy. Furthermore, curators have very little concern about handling such objects. As such, the potential to use 3DSP to play and experiment with collections is limited only by the curator's imagination.

Curators across Museums Sheffield and The British Museum perceived that a potential outcome of using 3DSP to play with collections was the re-actualisation of objects and their lifehood. Julia and Clare, who come from different museums and curatorial backgrounds, were keen to see how some of their objects would have been used before the objects became museum objects.

'I wonder if we could recreate a flagon to see the wine pouring out of the spout…. It would be lovely to play with the colour of the scan recreating what the flagons would have looked like, red and gold' (Julia - The British Museum).

'*All those tea pots I've got, I would love to use 3D printing to see how they work'* (Clare - Museum Sheffield).

Their comments talk of creating 3D replicas to explore how the original object could have been used. The notion of actually seeing how wine flowed out of the Basse-Yurtz Flagons creates a new form of experimental practice, whereby physicality is brought back to the museum and used as a method of research through which there is the potential to perceive new object and institutional insights.

6.4 New Insights

Throughout the Museums Sheffield and The British Museum residency, curators commented on how engaging with 3DSP processes and objects allowed them to see new details and perceive previously unrealised insights. The perceived insights were both object-based and institutional. Providing curators with the tools to engage with 3DSP, enabled them to think critically not only about their objects but also about the practices of the museum and the curatorial role.

Curators were especially excited about gaining new insights into their practice. New object insights were prevalent at Museums Sheffield, where curatorial conversations about the 3D printed ivories centred on how much detail the scanning process could pick up. On one occasion, when the enlarged plaques arrived for the handling section of the exhibition, curators held, passed around and felt the enlarged 3D printed plaques. Clare and Clara attempted to identify the different types of birds depicted by examining the plaque. This

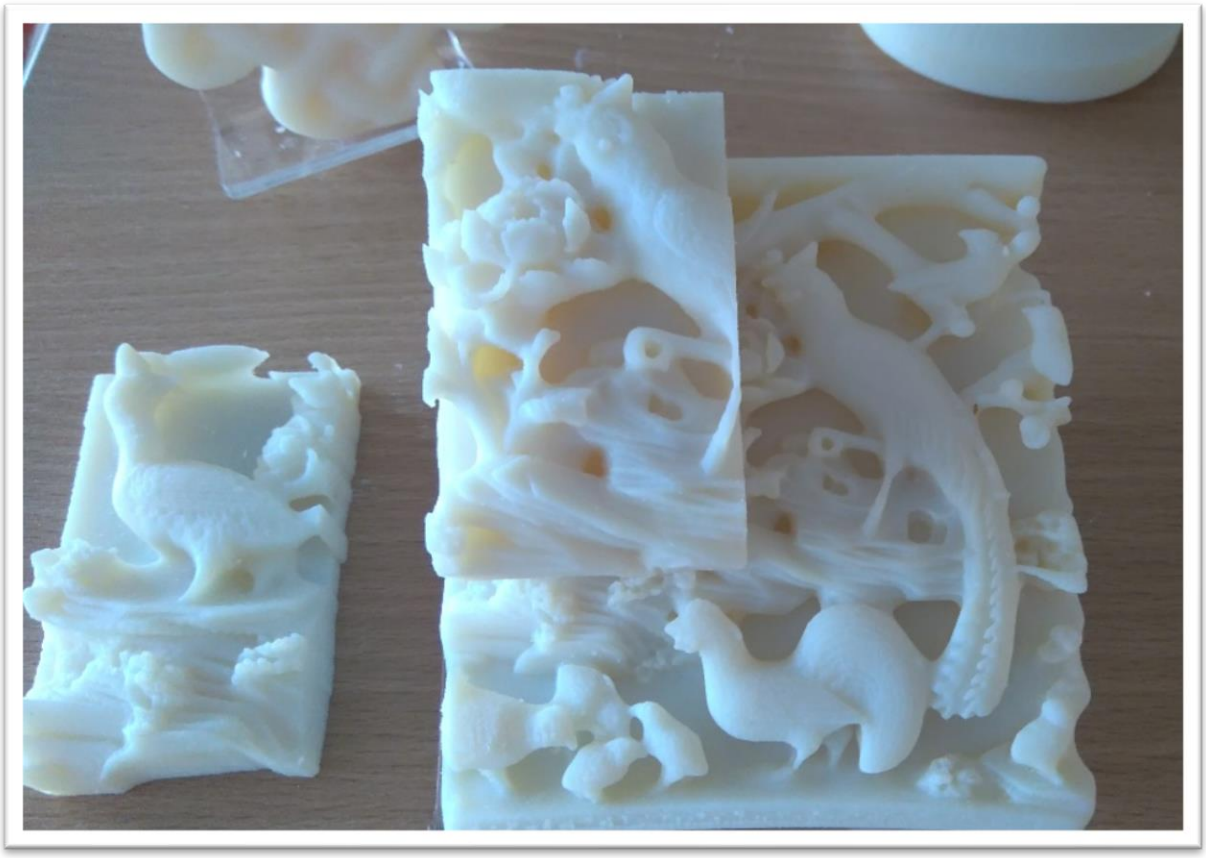


Figure 33 A photograph of the enlarged 3D printed plaques for the handling section of 'Stories from the East'

caused curators from Natural Science to join in the conversation, leading to a cross curatorial dialogue that forced all present curators to focus on one object.

The enlarged plaques (see figure 33), combined with the fact that 3DSP allows robust physical interaction, meant that curators were able to examine them more closely. This point is also explored in Ch.5 'The Curatorial Intention'. The act of stopping to look at and observe a single object over a prolonged period of time was seen as a distraction to daily curatorial tasks. Such an idea was supported by Martha who during a conversation stated:

'The copy is like a disruption to the museum process'. (Martha- Museums Sheffield).

Yet the above notion is not necessarily negative, since it makes the curator stop. It is through such a pause in practice that new object and curatorial insights become apparent. The practice of spending a prolonged period of time attempting to understand an object is reminiscent of old curatorial methods, whereby the curator was an expert in a particular area, often spending hours trying to know and understand their collection. As such, the introduction of 3DSP within the context of the museum has not only the potential to further

curatorial practice, but also to revive old practices, which have been forgotten due to contemporary organizational structures, resource restrictions and organisational targets.

The idea of previously unseen details was used in the exhibition 'Stories from the East: The Grice Ivories'. Throughout the exhibition's curation, curators commented on how the 3D scan and object could help them to understand the history of the object before it came into the collection. As Joy (2014) argues, the curatorial is a transformational process, which creates an artificial hierarchy of value that does not exist in non-museum collections. The use of 3DSP in museums potentially allows curators to look beyond the systems of categorisation to explore the objects' making, use, reception and loss. At The British Museum, the quest for new object insights was driven by two different initiatives. Projects such as The Gaye-Anderson Cat project and The Alabasters project were looked at from a scientific perspective, while others, including the Basse-Yutz Flagons project and The Votive Offering project, were considered from the perspective of dissemination and audience engagement.

The Gayer-Anderson Cat project sought to use a variety of 3D techniques to explore the cat's mode of production and later restoration. X-rays had revealed multiple breaks which had been repaired and consolidated with a large pipe. Surface scanning, conducted by myself, was used to capture the cat's texture, colour and patina. The X-ray and the surface scan were then combined to create a digital autopsy of the cat. For Neal Spencer, the use of 3D is bounded by scientific parameters. In his interventions, he wrote of using *3D to tell valid stories.* This is a complete contrast to Julia and Neil, who describe using '*3D as a form of free play… that breaks the linear nature of the museum'*. Neal's use of the term *'valid stories'* implies that some potential uses of 3DSP are of no value to the museum.

The difference in perspective might stem from each curator's experience in using 3DSP. For example, as explored in Ch.5 'The Curatorial Intention', Neal is incredibly knowledgeable when it comes to using the technology. He understands the challenges and the benefits of using 3DSP and knows what will work best for his collection.

Yet this approach to 3DSP was not the only way to reveal new insights into museum objects and practice. The Nereid Monument project and the Ringlemere Cup project both caused their corresponding curators to perceive new insights into their own practice. In her curatorial

interventions, Alexandra writes about the difference between traditional ways of creating digital models and 3DSP. Her comments are framed around the concept of accuracy:

'rather than relying on artistic impressions, 3D makes everything quantifiable. We don't have to rely on subjective impressions'.

Here the ability of the scanner, that of creating exact digital 3D copies of museum objects, provides curators with the opportunity to create accurate digital models in house and to do so quickly. The new insight is one of practice, as well as object-based knowledge. This is a point supported by Neil, who, regarding his Ringlemere Cup project, wrote in his curatorial interventions:

There is a novelty/contrast with 3D: here we have a really old thing in an institution that is considered to be quite 'dusty' but we can use this relatively new technology to look at the details of our stuff'. (Neil – The British Museum).

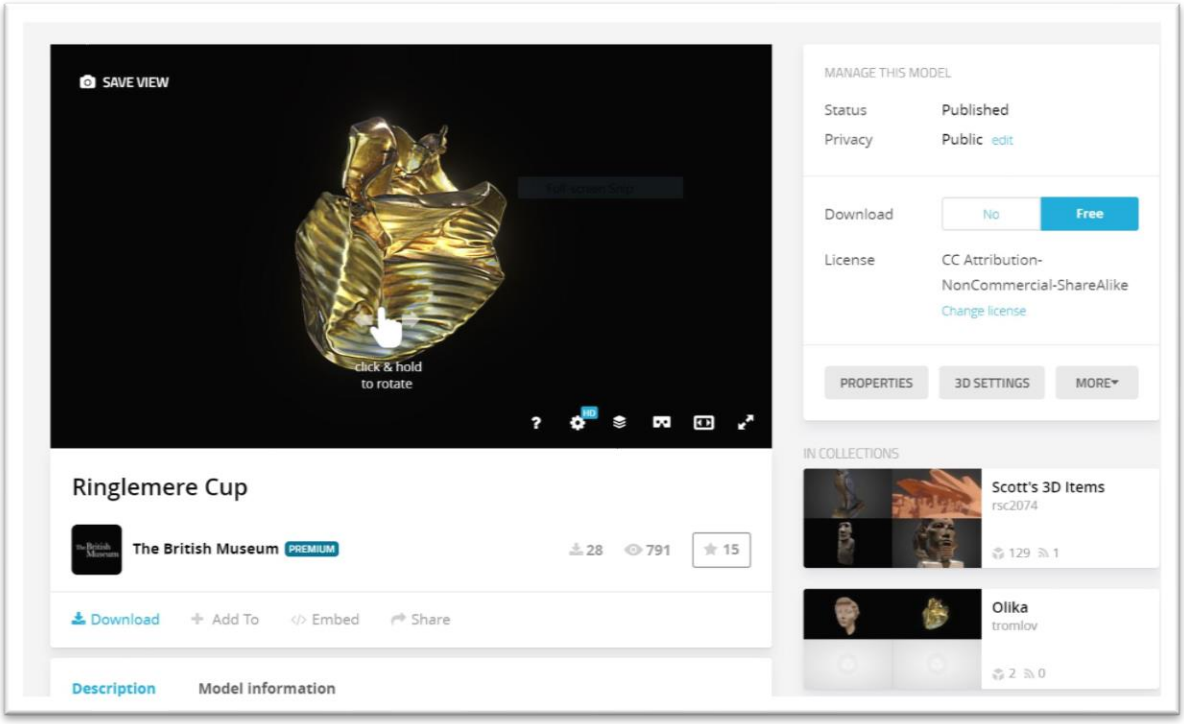


Figure 34 A screenshot of the uploaded 3D scan of the Ringlemere Cup

The novelty or contrast can be seen in the uploaded 3D scan of the Ringlemere Cup (see figure 34). Neil's comment alludes to new insights into current practice through the use of 3DSP. In this sense, both the process and the outcome of 3D scanning serves as a method of object engagement and understanding. These observations occurred by exposing curators to the

processes of 3DSP and by giving them prolonged exposure to the 3DSP objects. Here it can be argued that the methods used in this thesis have helped to reveal how 3DSP can support and further curatorial practice.

One such way that 3DSP can support and further curatorial practice emerged from the playing with collections and involved using 3DSP to bring back a sense of practicality to objects. Curators from across the museums were keen to explore and understand the lifehoods of their objects.

6.5 Object Relationships and Lifehood

The notion of bringing objects back to life featured in both sets of curatorial interventions. Curators such as Alistair and Martha used their maps to show 3DSP being used as a tool for re-actualising objects and Julia and Neil wanted to use 3DSP to help them to see how their objects would have been practically used. The idea of bringing back the lifehood of objects, or connecting objects with the people who once used them, is potentially linked to a desire to move away from the structures of the museum, as explored in the section above. Indeed, there is a sense of play embedded within using 3DSP to create a copy of a museum object and using it to explore the human history behind objects.

It has long been documented that the glass case has a hidden purpose which is that of creating a hierarchy of value (Merriman 1991), whilst simultaneously sanitising the object (Ames: 1992) and removing it from its once practical existence. Yet 3DSP allows for robust physical interaction, negating the need for the glass case. This is a point supported by Alister in his exhibition concept (see figure 12). As a result, curators are in a position to play, experiment and restore a sense of practicality to museum objects. In their curatorial interventions, Alexandra and Marie wrote about using 3DSP to relocate objects with the people who once used them.

'Using this technology, we could explain the way of life people in ancient times' (Alexandra - The British Museum).

…lifehood of objects which had been hidden or concealed for thousands of years (Marie -The British Museum).

Their comments are centred on understanding more about the historical time period of the object, the people who lived then and their way of life. Embedded within these quotes, especially Alexandra's, is a desire to communicate the past lives and uses of the object to audiences. This is a key practice of the museum and thus a way that 3DSP could be integrated into the practices of the curator.

The reasons behind the desire to play and bring lifehood back to objects is both an affordance of 3DSP and the changing social environment towards audience engagement. Yet the concept of objecthood and the lives embedded within museum objects is not a new concept within heritage (see Daston 2007, Smith 2010, Joy 2009), but the autonomy and once practical existence that this entails is. The idea of extending the museum object to include its past and future lives, especially those which have a technological origin, challenges the idea of museums being sites of uniqueness. As argued in Ch.7 'The Museum and the Digital', structural data used to create 3DSP objects is directly derived from its museum counterpart and, as a result, 3DSP objects have a relationship with the museum collection. Clare supports the idea of a perceived relationship between 3DSP objects and the museum collection by stating:

'It doesn't make me think of the original object differently. It's like a cousin familial rather than emotional.' (Clare – Museums Sheffield).

Clare's comments highlight the perceived relationship between the museum object and its 3DSP counterpart. The above quote can be seen as conflicting with previous quotes by curators, especially with regard to where the 3DSP objects sits within the museum and its perceived authority and authenticity. However, it can be argued that the concepts of authenticity and authority are perceived as emotional constructs, as they do not exist on a physical plane and can thus be separated from physical and structural relationships between objects.

The notion of revealing the past lives and polysemy of objects was explored in the exhibition 'Stories from the East: The Grice Ivories' staged at the end of the Museums Sheffield residency. The exhibition used 3DSP to create 3D printed details or features of the scanned museum objects (see practice-based submission pp.80-84). The idea of digitally breaking museum objects down into individual features allows audiences and curators to experience

more of the object, its stories, the people connected with it and how it was used through the creation of multiple layers of interpretation.

Such was the case for the figure of Liu Ji (1311-1375). In the exhibition, the sculpture stares upwards with a reflective expression, while his hands are clasped behind his back. At his feet is a 3D printed enlargement of his hands.

Figure 35 A photograph of Lui Ji and his 3D printed hands

Liu Ji is an important figure in Chinese history; his poetry, storytelling and skills as a war general were famous across the dynasty. Yet, despite this, he was falsely accused of treason and murdered. Today he is known as a martyr. His hands were the tools of his trade and by 3D printing and upscaling them, the importance of this otherwise unassuming feature could be seen (see figure 35). The 3D printed hands were placed in front of the museum figure, causing audiences to walk around the case and see Liu Ji from every possible side. The 3D

printed hands revealed not just the story behind Liu Ji but that of the carver as well, whose painstaking attention to detail included Liu Ji's fingernails.

The exhibition sought to provide alternative interpretation points and narratives through the use of 3DSP object details. These details were placed inside cases alongside their own interpretation label, allowing curators to reveal additional stories and ideas about the displayed museum object (see practice-based submission pp.83-84). Here, 3D scanning had facilitated a shift in perception. Objects were being viewed as composites of objects, additional stories were being told, audiences were able to handle the replicated objects and replicas were placed inside the case, creating additional points of interest.

The motives behind and the uses of 3DSP reflect the experiences, resources and culture at each museum. At the time of the residency, curators at The British Museum had access to digital expertise and funding to support research. As a result, a culture of practical innovation and experiment had evolved, as evidenced by the museum's Sketchfab account and the Virtual Autopsy table used in the Egyptian galleries. In contrast, Museums Sheffield lost their digital department, forcing their curators to adopt a 'do it yourself' mentality when they desired to engage with digital projects. The resulting differences between the two museums is perhaps why 3DSP discussions from curators at Museums Sheffield tended to focus on the technology in abstract and theoretical constructs. Again, in contrast, curators at The British Museum discussed 3DSP in very practical terms, using actual examples of 3DSP projects to support their comments.

However, these practical terms seem to apply only to the practical projects and the practice of the residencies. Throughout the residencies, curators at both museums spoke about the life of objects in abstract terms. When discussing the lifehood of objects, curators tended to refer to object birth and death, with the museum operating a pathway between them for select objects.

6.51 An Object Purgatory

The terms of 'life' and 'death' are used throughout heritage literature to discuss a particular set of relationships during its lifetime. For example, when an object's current use or association with a set of relationships ends that particular aspect of its lifehood dies (Holtorf 1998). However, the museum with its processes of transforming objects into 'museum

objects', offers an exception to the concept of birth and death of object lifehoods. For once an object enters the categorising frameworks of the museum, the likelihood is that it will never leave. As such, it can be argued that the museum could be an intermediary between the life and death of objecthoods: a form of earthly purgatory.

As Joy (2014) argues, the curatorial process is transformational, transforming the object into something very different without ever altering its physical state. The museum is essentially a container for exhibits. It can offer a more aesthetically pleasing presentation merely by isolating an object from its original context and reframing it for a more considered viewing (Putman 2009: 36). Curators from Museums Sheffield furthered this point by asserting during a group conversation about what museums do to objects:

…*I've got the birth to death of an object. They are born from something, they have a life, are used and then discarded or put away*. (Clare) *An afterlife in the museum*. (Leighanne). *It's where good objects go to die and be reincarnated. They're not the same, but the tea pot will never be used as a teapot again* (Martha).

During the object's 'life' as a museum object, it acquires and changes its meanings as a result of the triangular relationship between the artefact, the way it is displayed and the affective and cognitive response of the audience (Akker and Legêne 2016: 7). However, when an object becomes a museum object, it is its final life; while it might have sub-lives within exhibitions or as part of external loans, it is highly likely that it will never not be a 'museum object' and thus is never likely to 'die'.

Yet a 3DSP object, on the other hand, operates in a slightly different world. The 3DSP object sits in a museum purgatory; it is neither a part of nor separate from the museum. Yet its scan data is directly derived from the museum collection. The museum does not want to accession 3DSP objects or store the data. On the one hand, this is a statement of perceived value, highlighting the perception that this form of data is not worth storage and preservation. Yet, on the other hand, it places 3DSP objects in a unique position. Without the protection of accessioning, these objects can be removed from the museum at any time, manipulated, and played with. While, they may be in a status of limbo, they are also free from the constraints,

rules and policies of the museum. This was an affordance that did not go unnoticed by curators at both Museums Sheffield and The British Museum.

6.6 Conclusion

The introduction of 3DSP within the museum provides opportunities for curators to consider their practice in a new way and also to advance their understanding of the objects they work with. During both residencies, curators from across The British Museum and Museums Sheffield saw ways to engage with 3DSP that would support the museums' core mission and their own practices as experts of their collection. Despite concerns surrounding authenticity and authority, which seem to exist for all forms of museum replicas, the uses of 3DSP were perceived as means of furthering museum practice, through the medium of play.

The medium of play has the potential to challenge the heritage hierarchies of the museum in favour of a multi-layered narrative that reveals the polysemy of objects and the complexities of their past lives and relationships. This reflects contemporary notions of heritage thinking and promotes the relationship between the curator, audience and object. Here the individuality that is promoted within contemporary heritage discourse not only relates to the visitor, but to the object as well. It transforms the narrative around the object, changing it from a passive and singular artefact to a complex artefact with its own autonomy. In this sense, the use of 3DSP within the museum has the potential to create a more democratic object experience where visitors both online and physical, are no longer 'guided' by the authoritative voice of the museum.

The potential of 3DSP to support curatorial practice within the museum is focused on the ideas of creating play within the collection, supporting more complex interpretation strategies online and providing reflexive opportunities for curators to explore their own practice. Yet the 3DSPs introduction to the museum is not without concern.

It is clear that 3DSP is perceived as presenting some level of frustration to the structures of the museum and its objects, although the reasons behind this frustration cannot simply be defined as a move of power or a restriction of autonomy. How the museum and individual curators become involved with 3DSP seems in certain contexts to be deeply a personal relationship (explored in Ch.5 'The Curatorial Intention') around historical practices, the desire to innovate, material and aesthetic properties and prior experiences with 3DSP.

Here, there is a dualism at play between the perceived benefits and the challenges of 3DSP in the museum which impact on how the technology and its associated objects are received. The physical appearance of 3DSP, its contemporary manufactured material and its materiality frustrate the museum's identity of 'uniqueness' and cultural significance. Yet, at the same time, curators across Museums Sheffield and The British Museum recognised the enrichment that such objects can bring to object engagement, through object dissemination and physical interaction. Embedded within the concept of physical interaction and object dissemination are the concepts of play and bringing a lifehood back to museum objects. These concepts offer a new form of curatorial practice to curators and allow insights into the objects to emerge.

7. Museum and The Digital: 3DSP its Challenges and Affordances

7.1 Introduction

In this chapter, the focus is on the digital challenges and the benefits of introducing 3DSP into the practices of the museum. The chapter explores first how curators treated data points added by the scanning software, before examining how 3DSP has affected copyright and intellectual property laws within the museum sector. Finally, the chapter examines the logistics and storage concerns that curators had about documenting 3DPS objects and their corresponding data files, including considerations of storage and documentation.

The chapter draws together the curatorial interventions from Museums Sheffield, The British Museum and the exhibitions 'Frustrating the Linear' and 'An Object in Transition', to examine how 3DSP is affecting the digital aspects of museum practice. However, it is important to mention that the majority of the data examined in this chapter came from The British Museum, as the digital logistics of using 3DSP within the museum were of a key concern for both curators and members of the Digital Humanities team at the museum.

7.2 False Data

The term 'false data' is applied to the inclusion of additional digital data points that do not correspond with geometry on the physical museum object, i.e. missing pieces of data that have been filled in by the software or added data from specularity or noise. False data became a prevalent topic among the Digital Humanities team at The British Museum, especially when discussing 3DSP and the value it can add to the museum experience. In general, the Artec scanners struggle to see inside small spaces such as the insides of vases or jugs. As a result, certain aspects of the object became almost impossible to scan. The processing software then meshed over holes and created surfaces that were not present on the physical museum object.

The concept of false data was first noted in the Acclimatisation Study (see practice-based submission pp.20-23) which describes how curators and myself looked at how holes, movable parts and internal surfaces became fused. There was interest in how the different stages of the post-processing impacted on the perception of the 3D scan. The holes present in the surface of the beaker (see figures 36 and 37) created by missing pieces were filled in during the 'Fusion' phase of the process, causing black patches on the beakers' surface.

Curators at Museums Sheffield commented on how these patches appeared to be masks, shielding the viewer from the story of the beaker's past. By concealing part of the object, the processes embedded in the software were effectively distorting the object's history. The curators commented on how the speciality of the object had been lost. As 'meaning is only ever "read into" things' (Graves-Brown 2000: 4), the 'speciality' of the object is therefore affected by the rendition quality of the scan.

Figure 36 3D scan of a bronze-age burial pot without a fusion applied to the holes in the pots surface

Figure 37 3D scan of a bronze-age burial pot with a fusion applied to the holes in the pots surface

At the British Museum, the concept of false data was noted during The Gayer-Anderson Cat project. The scanner struggled to capture a large indentation on the base of the cat, despite several attempts being made, and so an artificial dome was created during the processing phase. This struggle was in part caused by a number of variables all acting upon the scanner with varying degrees of force. They were by no means limited to alignment constraints, pilot error or temporal and atmospheric conditions.

Yet according to curators, the addition of this data may tell audiences about the specific depth of the indentation on the cat's base, which is false object information and thus not an accurate representation of the cat. My own diary writings explored this curatorial concern (see figure 38), highlighting how Daniel and Neal questioned how museum audiences would interpret additional data points, and whether the museum should be honest about missing and filled in data points.

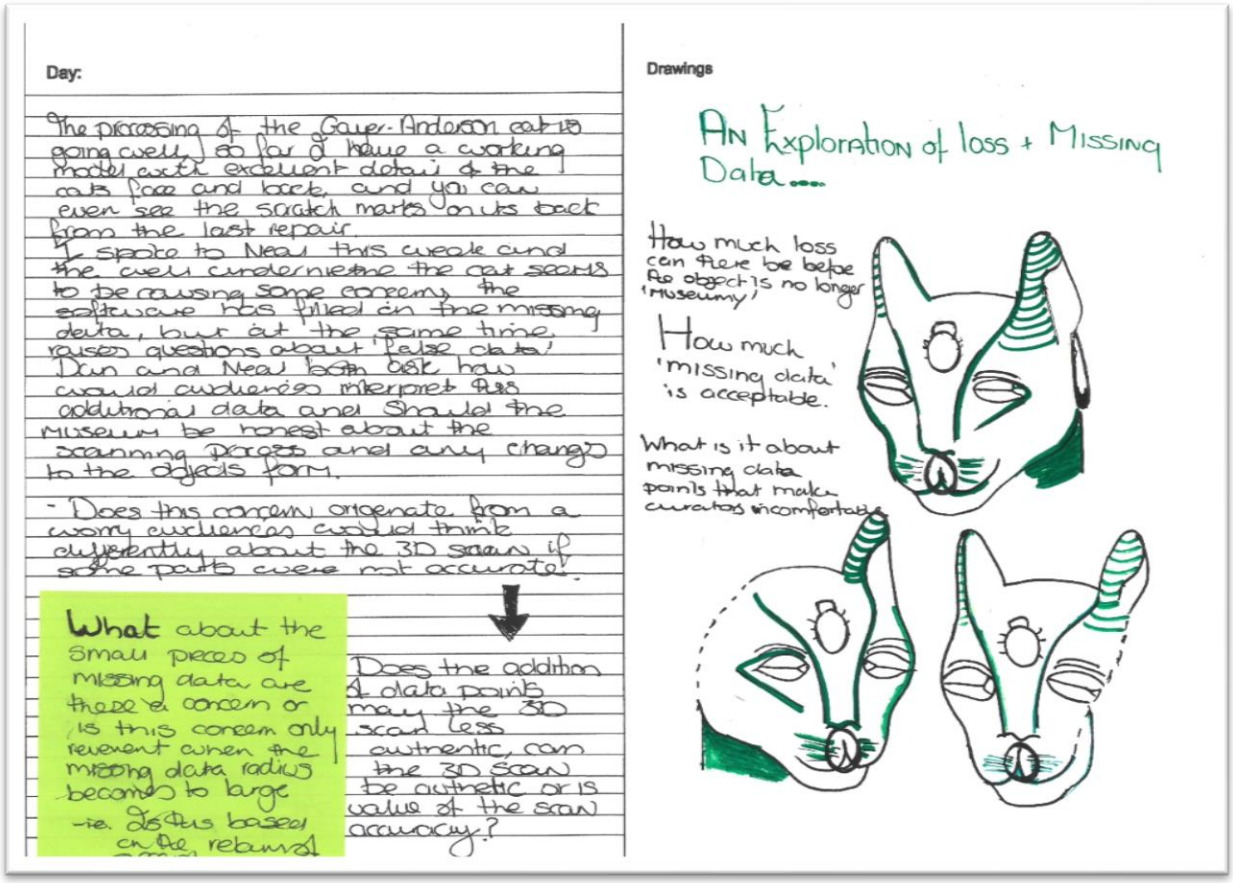


Figure 38 A example diary page from The British Museum Residency where I explore the concepts of False Data

In my writings (see figure 38), I question why curators would feel like this, given that the 3D scan and the museum object were related but disparate objects. I wondered whether the addition of false data impacted on the accuracy of the scans perceived, potentially diminishing their value to museum practice and audience enrichment.

These questions were discussed at some length between the Digital Humanities team, curators and myself. We debated how best to deal with false data from both a curatorial and scientific perspective, as 3DSP transcends the normal boundaries of practice and has roots in curation, conversation, audience engagement and museological research. The ideas for dealing with false data included patching the missing data and leaving the patch as the software had processed it or beautifying the model, giving the impression of a perfect scan.

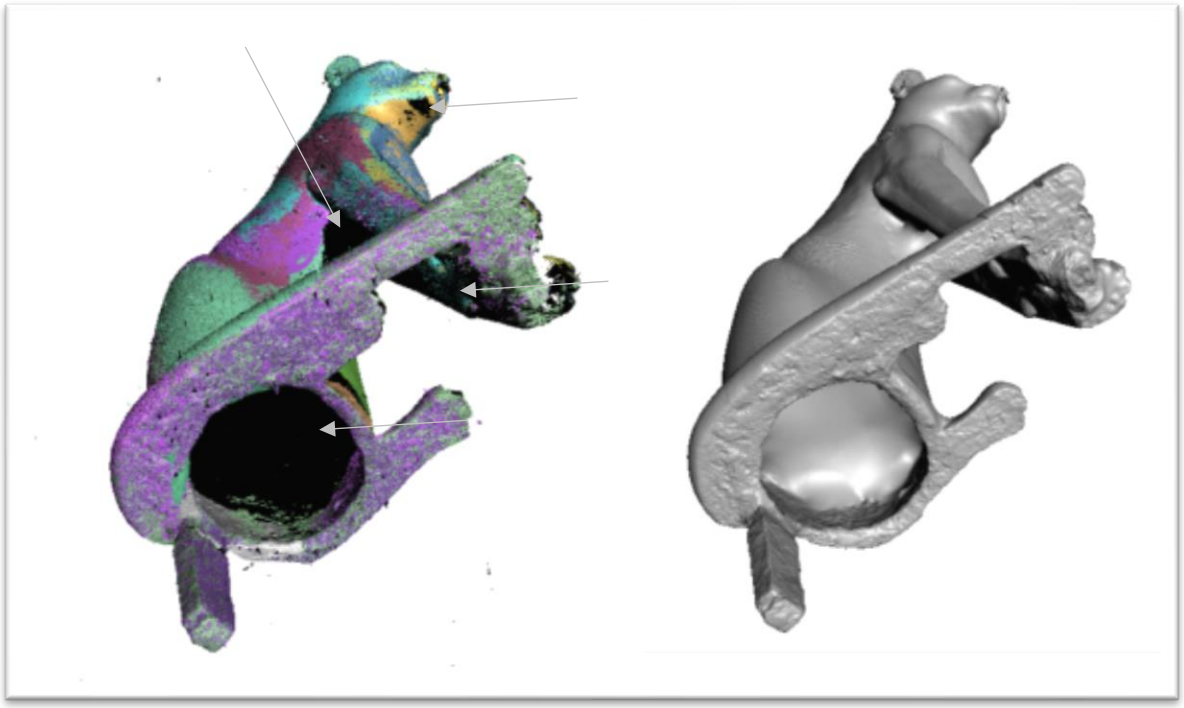


Figure 39 An illustration showing the false and missing data on The Gayer-Anderson Cat

The debate and concern over false data seemed to be dependent on the size of the missing sections of information. For example, Daniel and Neal were focused on capturing the underneath of the dome rather than the other pieces of the data that were missing, such as under the cat's chin, on its chest and paws (see the grey arrows on figure 39). This implies a relationship between the size of the missing data and the need to capture accurate scan data, as if there is knowledge which the scanner's algorithm can create with an accurate surface mesh for small pieces of missing data.

The discussions around false data are new to the museum narrative but have implications beyond the visualisation of the object. There is, in essence, an argument about whether the museum experience or the dissemination of factual object information is more important (see Falk and Dierking 2011, 2012). Daniel and other members of the Digital Humanities team considered 3D scanning and the processing involved as an artistic process, whereby the person in charge of scanning and post processing makes subjective decisions regarding data points, surface quality, resolution to name a few. This is a point supported by my own 3D

scanning practice (see figure 40), where I experiment with different settings, colour and resolution in order to obtain an accurate 3D scan.

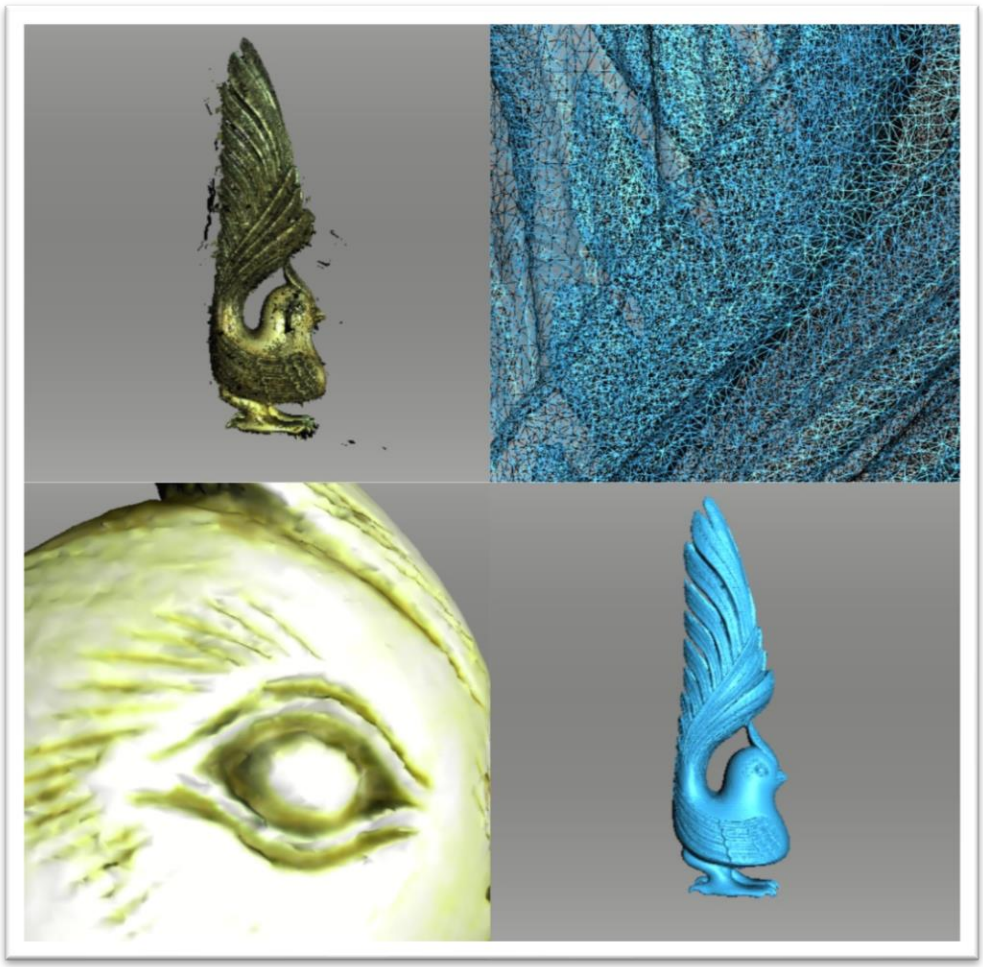


Figure 40 An illustration showing how the museum object changes as it moves though the 3DSP process

Figure 39 is an example of how the processes and features of the processing software affect the visual appearance of the scan data, whether it be by transforming a solid mesh into a wire frame or manipulating the colour of the meshes. Such applications are not present in current museum practice, since the appearance of the museum object never changes.

During The British Museum residency, we had several discussions regarding the reproducibility of data and where false data sits within the scan, its data set and overall documentation. The desire to acknowledge false data is a statement of honesty and one that reveals not only the challenges of 3D scanning but also gives information about the form of the object.

Yet how false data was perceived differed from object to object, such was the case for the Cornell-Cael bell cover (see figures 41 and 42), which houses a clear crystal on its front. This part of the object was impossible to scan with the Artec Spider, as the scanner's light travels straight through the crystal and is not reflected back. As a result, false data is added during the post-processing phase to patch holes that the software's fusion algorithm had missed. Here, false data is neither overtly positive nor negative and how it is perceived is dependent on the object in question. In the case of the Gayer-Anderson Cat, false data obstructed the actual shape of the dome underneath the cat, while for the Cornell-Cael bell, false data was used to given an impression of what the bell cover would have looked like. The use of false data for the bell cover actually helped to support curatorial object-based research.

Figure 41 A 3D scan of the Cornell-Cael Bell Cover with texture

Figure 42 A 3D scan of the Cornell-Cael Bell Cover without texture

However, the concept of false data was not just a curatorial concern but also a concern of the Conservation and Science Teams at the museum. For example, the polychromy scientist, Joanne, commented on how specularity on the surface model of the Carien Stela could be misconstrued as tool marks, thus portraying false information and misleading audiences. In a discussion between myself and Joanne, she was concerned that the horizontal lines running across the surface of the model (See figure 43) would be interpreted as tool marks among non-expert audiences and thus create false object taxonomies. She writes in an email:

'I am worried the weird lines running across its surface might be considered tool marks' (Joanne – The British Museum)

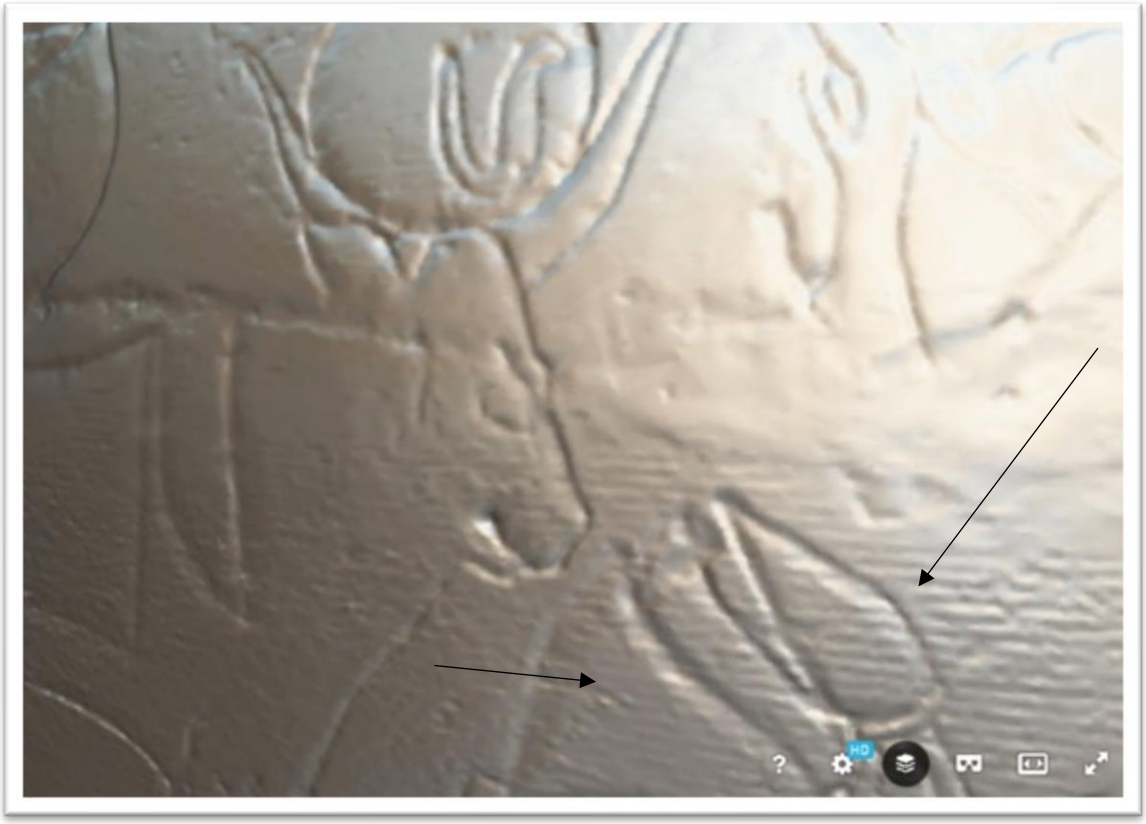


Figure 43 A close up of the Carien-Stela with specularity

Here the act of 3D scanning and post processing is not considered as an artistic process, where inaccuracies can be considered as part of 3D scanning and printing, but are merely mistakes in the mesh, which can be interpreted as false information, that can lead audiences and professionals to form potentially historically inaccurate object histories.

The different attitudes with respect to false data highlight how the use, application and creation of 3DSP differs within different museological teams. The museum/archaeological backgrounds of the Digital Humanities team meant that the use of 3D was a speculative tool for experimentation. This level of play and experimentation was present within the Science and Conservation Teams but there was less of a playful attitude towards 3D. The discussions surrounding 3D and where it sits within the museum brought to light powerful problems about what knowledge is and how the museum operates either to conceal or reveal structures of information.

7.3 Power plays

The notion of certain parts of the museum manipulating the integration of 3DSP had not been considered prior to starting the Museums Sheffield residency. Yet, when co-curating 'Stories from the East: The Grice Ivories', the labels for the 3D printed details were altered by Senior

Management to reflect a process of manufacture, rather than linking them to the main theme of the exhibition (as explored in Ch.6 '3DSP Objecthood and Curatorial Practice'). The interpretation for the 3D printed details was designed by Clare to tell additional stories about the objects (see figure 18 in the Ch.6 '3DSP Objecthood and Curatorial Practice'). The move to position the in-case 3D printed objects as manufactured objects implied a desire to distance 3DSP objects from their historical counterparts, and thus worked against the desire of the curator in charge of the exhibition. Here, the use and positioning of 3DSP highlighted how different departments and levels of seniority could work against each other, perhaps on account of the novelty and lack of precedence that the technology had in the museum. The act of changing the museum labels was an act akin to that of curators not wanting to accession 3DSP objects into the core collection. It had the same outcome of distancing 3DSP museum objects from their museum counterparts.

Yet, as highlighted previously in this chapter, the decisions made about the use and response to 3DSP can vary between collections and even between objects. Curators at Museums Sheffield wished to position 3DSP objects as interpretative aids, but, at the same time, commented on how they would never display a 3DSP object on its own. In a conversation previously explored between Clare and Martha, the two curators talk about how they would and would not display 3DSP objects.

I can't see a situation where I would put only the 3D scan and object out, unless as with some of the objects we have in our collection where the object was in a different museum and the only option we had was the 3D objects, then you might talk about it, but then 3D scans and objects don't look nice enough to be objects in their own right, because they're plasticy (Clare – Museums Sheffield) *You wouldn't discuss the 3D object on its own in the context of the museum* (Martha- Museums Sheffield).

The power plays between senior management and curators regarding the integration of 3DSP does not come from an authoritarian position but is deeply related to the recent use of 3DSP and how the very fact that it is technological challenges the nature of the museum. Here, it can be argued, curators, non-curatorial departments and senior management are all responding to 3DSP based on their own experience of the technology and what they deem as a 'correct' course of action.

Embedded in this course of action are complex concepts which include, but are by no means limited to, the traditional practices of the museum, financial and moiety expenses, audience and stakeholder expectations and the care of the object. Evidence for this is noted in Clare and Martha's conversation above, where their comments about the object 'not being nice enough' can be perceived as their way of considering how audiences would respond to seeing 3DSP in the gallery context.

Playing with how 3DSP is used in the museum was also noted at The British Museum. During the residency, 3DSP was largely created by Daniel Pett, with curators having access to add interpretation and to share their 3D content freely on Sketchfab. However, as this residency progressed, the Information Services team became more aware of the possibilities associated with 3DSP content. There were several meetings on the metadata and version control of 3DSP content, with different departments highlighting concerns over logistics and practicalities. This concept is explored in my own diary writings (see figure 44 on p.139). Upon finishing the residency, the Information Services team decided to restrict access to the museum's SketchFab account, potentially out of concern for the yet unrealised possibilities of 3DSP, including the impact that this technology would have on copyright and intellectual property rights.

7.4 Copyright and Intellectual Property

3DSP presents a new and complex challenge to museums and one that cannot be solved within the confines of this Ph.D. for, as Fyfe argues, the authorship of historical digital objects has been an area of contestation for decades (2004: 51). As costs fall and technological advancements rise, 3DSP is becoming an ever more ubiquitous resource in the museum sector. Museums are keen to attract new audiences, widen their public engagement and deepen understanding of their collection by turning their modes of delivery and audience engagement to the emerging channels of our evolving digital society (Perry 2009).

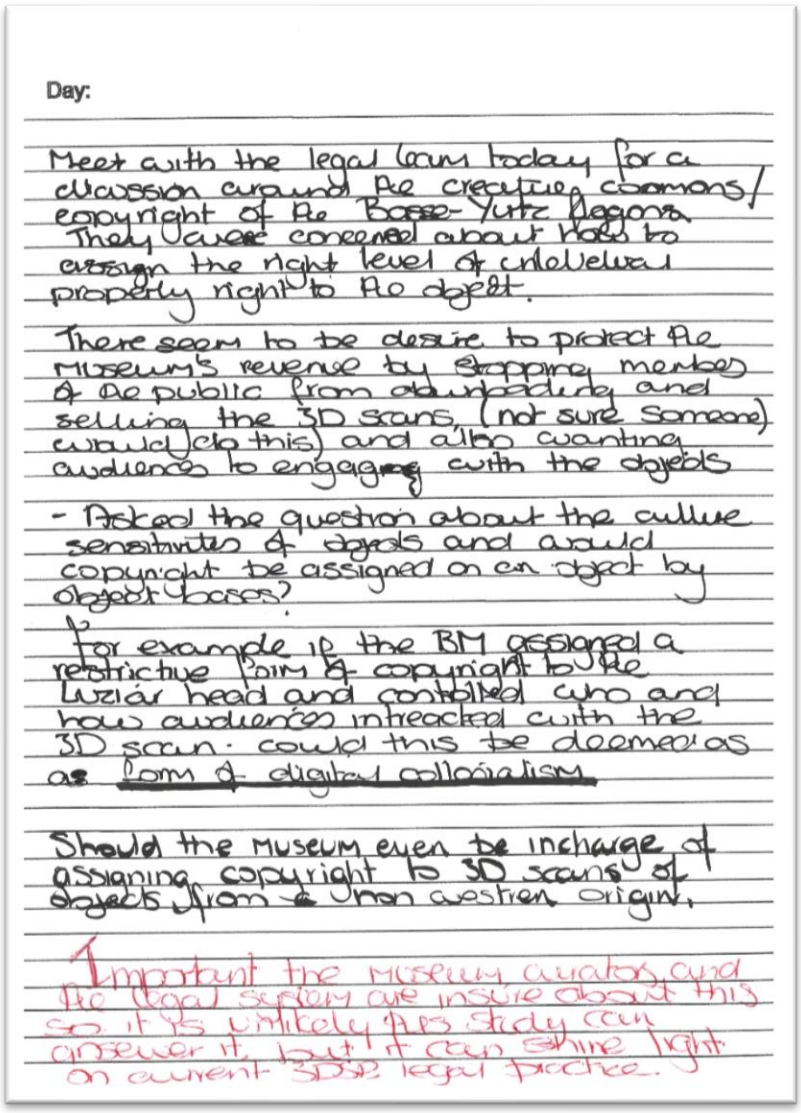
At present, the British Museum - as with many other museums - is unsure of how to deal with copyright, preferring to take a semi-democratised stance, sharing its 3D models on Sketchfab under the Creative Commons License of CC-BY-NC-SA but, at the same time, restricting access for curators and limiting their ability to create and upload 3D content. There is a desire in the museum to retain ownership and control over 3D digital files, especially those which relate to culturally sensitive objects.

Such a move causes access concerns when curators are working with external organizations, particularly those who want to purchase 3D assets. Such was the case for the Basse-Yutz project which sought to create 3D printed replicas for a French Museum. The British Museum required the French Museum to sign an access and use agreement if they wanted to use the digital models of the Basse within their museum. In essence, and as explored in Ch.6 '3DSP Objecthood and Curatorial Practice', the agreement would allow the French Museum to manipulate the models digitally but would prevent them from using the 3DSP object for commercial gain. Combined with the above agreement was an administration cost, a fee that curator Julia struggled to understand. In Julia's diary pages (see figure 15 on p.84) she writes that she struggles to see how the museum does not perceive the 3D scan as an image.

It seems that there is a disconnection between the desires of the museum and its curators. Both The British Museum and Museums Sheffield wished to retain control over 3D data sets, perhaps as a future-proofing mechanism, until the intellectual property rights pertaining to 3DSP, including how to assign rights in accordance with the law and the museums' desires, were fully understood. For, at present, there is no legal precedence with regard to 3DSP and copyright.

Yet curators recognised the value which 3DSP could bring to museum practices, as discussed in Ch.5 'Curatorial Intention' and Ch.6 '3DSP Objecthood and Curatorial Practice'. However, it is hard for curators to break away from their institutions' culture, especially when there is a wish to engage, as well as a simultaneous uncertainty as to how a technology or tool would impact on future practice. Discussions with the legal team at The British Museum revealed an uncertainty as to how to apply Intellectual Property Rights effectively, ensuring that 3DSP could be used in accordance with the desires of the museum, but also not be limited by an overly restrictive Creative Commons License. The British Museum was concerned that members of the public would use online 3D scans as a means of making money for themselves, or use the 3D scan in culturally inappropriate ways. Curators and members of the legal team questioned what the right Copyright or Creative Commons License was and what would happen if the assigned Intellectual Property Rights were deemed to be too restrictive or too lax. This is a point supported by my own diary writings (see figure 44 on p.139) where I question what the right level of Creative Commons License would be and The British

Museum's flow chart interventions (see practice-based submission pp.93-96) which reveals uncertainty over whether to assign copyright or not.


Day:

Meet with the legal team today for a discussion around the creative commons/ copyright of the Basse-Yuitz flagons. They were concerned about how to assign the right level of intellectual property right to the object.

There seem to be desire to protect the Museum's revenue by stopping members of the public from downloading and selling the 3D scans, (not sure someone would do this) and also wanting audiences to engage with the objects

- Asked the question about the cultural sensitivities of objects and should copyright be assigned on an object by object bases?

for example if the BM assigned a restrictive form of copyright to the Luzia head and controlled who and how audiences interacted with the 3D scan. could this be deemed as as form of digital colonialism

Should the Museum even be incharge of assigning copyright to 3D scans of objects from a non western origin.

important the Museum curators and the legal system are insure about this so it is unlikely this study can answer it, but it can shine light on current 3D legal practice.

Figure 44 An example diary page from The British Museum Residency

Table 2 on p.140 shows how all participating British Museum curators would, or would not, assign copyright. It highlights the curators' awareness of the implications of assigning Copyright and Creative Commons License to digital heritage objects but it also reveals their unease over stating outrightly how and in what form. Their trepidation at stating outright how rights and permissions should be assigned might be related to a need to check with the institution as a whole and the legal team. However, there is also the possibility of curators wanting to assign copyright on a case by case basis, responding to the complexities and the cultural sensitivities of each object.

This is not a new form of practice within the museum, since copyright is considered for each out going loan. Yet such a practice is centered on physical museum objects and not on digital reproductions. As such, the introduction of 3DSP could cause museums to reconsider how they lend out and assign copyright to a digital object.

Table 2 Curatorial Response to assigning Creative Commons License to 3DSP objects

Curatorial responses to assigning Creative Commons License in the objects in their projects	
Presumably (John)	(Marie)
Yes (Neal)	Not Sure, presumably yes (Alexandra)
Don't Know (Thomas)	Whenever possible (Neil)
Yes (Lloyd)	Possibly, I would like to say yes but it may not be possible where culturally sensitive objects are concerned. (Julia)

The last comment by Julia denotes the complexities and the struggle of curators in assigning copyright to digital heritage artifacts. There is a wish to increase access to their objects, but at same time it is hard for curators to assert a level of copyright given the lack of knowledge that surrounds 3DSP and Intellectual Property Rights. Furthermore, curators also have a duty of care, in this case protecting the digital legacy of their objects, for, once a digital object has been uploaded to an online 3D visualisation platform, the potential for the object to be downloaded, printed and augmented is limitless.

7.5 Metadata and Storage

Museums Sheffield and The British Museum both struggled with storing and visualising 3D data, a testament to the fact that data storage is not just a national museum concern. Data storage and visualisation are far from being new concerns. They have been prevalent in the museum sector for many years. Yet the concern emerges when museums recognise this but fail to act, preferring instead to outsource the management, storage and visualisation of their 3D data sets. Presently, and during my time at Museum Sheffield, the museum had outsourced the storage and visualisation of their 3D objects (from the JISC 2004 project) to an external company. The British Museum has used a similar tactic, by using Sketchfab to host their 300 + 3D models with the associated data sets spread across multiple internal drives and GitHub.

It is the persistence of data, its changeability and the means to read and store data that challenge the traditional practices of the museum, with 3DSP being its most contemporary trial. Updates, different scan processing procedures and augmentations caused by uploads to various 3D platforms, all affect the metadata and version control of 3DSP data, a key concern for an institution that is founded on categorising and ordering objects.

Digital representations have always been considered as secondary and marginalised within museum practice (Perry 2007). The fact that digital objects are not accessioned is a prime example. Yet the museum still wants to retain ownership over them, from fear of how other institutions and people would manipulate or reinterpret the 3D models. Even the concept of creating metadata for 3DSP objects was objectionable for curators at Museum Sheffield. When asked to document a 3DSP object created from her collection, Clara from Museums Sheffield stated *'we simply wouldn't accession such an object*' preferring to position 3DSP objects in undocumented handling collections. It is here that practice and theory tend not to meet, for Manovich (2001) argues, quite rightly, that new media is culture encoded in a digital form.

The above statement from Clara is not only a statement of perceived cultural value but also one about the value of the metadata surrounding 3DSP. John Giblin, Curator and Head of Africa at the British Museum, asked what the cultural and physical implications of documenting these types of data are. In his diary writings, he notes:

'Is scanning separate or should it be an extension of the online collection? E.g. Every object to be scanned to reduce need for access to see real objects in storage? What are the implications of this?'

The implications of including 3DSP objects in an E-collection extend far beyond curatorial and storage concerns to include theories of heritage, its politics and its practices. For, to exclude 3DSP from an E-collection is a statement of perceived cultural worth. Yet to include such objects is not merely a statement of value but would require a potential re-design of the museum categorisation softwares. This is a point supported by Clare from Museum Sheffield who states

It's just not possible for us to store these things; we just don't have the space.

The context of the above statement was in reference to both 3D scanned and printed objects. The future proofing of digital heritage is not without its issues. The ability of the museum to store effectively large data files is not only limited to the pre-existing servers and cloud-based storage already in operation. Issues concerning reproducibility, visualisation, longevity and access also remain a prominent barrier to working with and disseminating 3DSP objects.

There is a recognition among museum departments that is echoed by academics that metadata needs to be regulated (Thwaites 2013). Yet museum departments struggle to agree on which metadata to store, given that their individual agendas differ so greatly. As Keene argues, these works can be copied an infinite number of times without detriment to the original, yet it is difficult to recreate the exact circumstances of their delivery (2006). This is an aspect highlighted in the accession task which was part of the curatorial interventions at Museum Sheffield.

When completing the accession task, curators commented on the difficulties of the task. They struggled to fit the properties of the 3DSP object and its relationship to other objects into the record. When completing their accessioning curatorial interventions, they commented as follows:

'I don't understand how the object fits into this'. (Martha- Museums Sheffield)

'What number should I give it? Obviously not the same as our one.' (Alister- Museums Sheffield)

'I'm not going to mark the object, as it's not going to be a museum object' (Leighanne- Museums Sheffield)

The results were a series of object records that did not take into account the complexity of 3DSP museum objects. The records omitted metadata relating to previous versions, object relationships, processing techniques and the objects' G code. It is important to state here that this is not the fault of the curator, but rather that contemporary documentation software does not allow the curator to take into account digital creation methods, code, or document version control. Perhaps this is because of the assumption that museum objects have always been thought of as unique entities. A potential issue considering 3DSP objects can, as was

mentioned earlier, be printed multiple times with limitless iterations. As such, 3DSP has the potential to affect the very heart of the museum, its categorising process.

In response to gaps in knowledge, which were discovered during the Museum Sheffield residency, curators at The British Museum were asked to complete a metadata task, where they had to write down important information about the 3DSP process with the idea of reproducibility in mind (see Table 3). The results showed that curators at The British Museum were keen to document the 3D scanning, recognising how the lighting and scanning setting would have affected the scan output. There was a desire to locate 3DSP objects within the museum, potentially as digital heritage is often available in a de-contextualised way, separated from scholarly documents, field notes, photographs and illustrations that allow audiences to extract information for their models (Champion 2018). It was interesting that none of the curators thought to include formats of export files, perhaps because such a concept, the physical transformation of objects, has yet to be integrated into curatorial practice

Table 3 List of key metadata needed for accessioning 3DSP objects.

List of key metadata needed for accessioning 3DSP objects.		
Technical	**Object Related**	**Informational**
Computer program used	Object measurements	Rights and Permissions
Scanner Used E.g. Model	Any previous conservation	Date
Other scanning techniques	3D printing material	Time
Processing stages		Museum object information
Construction techniques		Location
Scanning Settings		
Lighting conditions		

7.51 Considering Storage

Throughout the two residencies there seemed to be a lack of urgency to solve the ever-growing data storage, issue but from different perspectives. Curators at Museums Sheffield commented on how digital projects were often out-sourced and created data that they could

not access or understand. In a conversation about digital museum projects Clare stated the following:

'When projects end, we end up with a pile of discs with files we can't access or understand' (Clare - Museums Sheffield)

Such a statement potentially stems from the fact that Museums Sheffield do not have a digital team or department and this inevitably results in the culture of the D.I.Y curator. Such a problem is not evident at The British Museum where staff benefit from experts in data management and information services. Yet the museum was still concerned about how 3DSP could be documented and also about the amount of 3D data which was being produced. This was evidenced by the fact that, soon after my residency at the museum ended, the 'Information Services Department' restricted access to the Sketchfab account, blocking curators off from several ongoing 3D projects (see figure 21 on p.94). This move was potentially one of control, restricting the creation of 3DSP data until it could be better understood how it would sit within the framework of the museum. The consideration of data and storage raises questions about where 3D fits within the museum. Looking beyond The British Museum to other national institutions using 3D, it lends itself to the practices within Science, Research and Conservation departments. The Natural History Museum (n.d.), for example, situates surface scanning within their Image and Analysis Centre and The Victoria and Albert Museum (n.d.) positions all the 3D work it undertakes within its Conservation Science Department, as well as actually accessioning 3DP objects into collections such as the 3D printed 'Liberator Gun' at the V&A (2015).

At The British Museum, it was not curators who recognised the changeability of 3DSP data but members of the Information Services (IS) team who held various meetings about how to deal with this type of data. Within these meetings, a main concern was the sheer volume of data that 3D generates, especially when reproducibility is taken into account. Version Control, raw data, processing records and texture files need to be considered. As MacLeod (2005) argues, the museum is in a constant state of reinvention as it deals with external, financial, environmental, educational, and societal forces as well as expectations of what a museum should be. Yet the technological requirements needed for 3DSP are beyond what the museum has ever experienced before and thus they leave the museum in uncharted territory. In his diary writings, Neil wrote about how 3DSP brought out a sense of curatorial insecurity. He felt

that 3DSP allowed objects from different collections to be compared as the digital scans did not belong to any formal collections.

'And yet… something about the modern technology - and the sense of being compared to other scanned objects (from Egyptian and Roman worlds), brings out a sense of curatorial insecurity'. (Neil- The British Museum).

The object Neil is referring is The Ringlemere Cup, a gold cup which features prominently in The British Museums' Bronze-age display. Yet in traditional museum practice objects from different collections, regions and cultures tend not to be compared. It shows how the rigid categorising of the museum seems to be worn down by the instant accessibility of 3D scans. Curators commented on how they could view other cross-departmental curators' objects without the constraints of going through collection management software. At first, I thought this was a statement of access but it was also a statement of how 3DSP pulled at the curatorial boundaries of categorisation, consequently frustrating the categorisation systems and frameworks of the museum.

The installation 'Frustrating the Linear' (see figure 45) attempted to visualise the impact which 3DSP has on the museum archive and to prompt further examination of it. The work was positioned as a performance piece with images, datasets and objects visualized together to reveal often hidden relationships between frequently related data. The work was installed, taken down and then reinstalled a number of times in front of different audiences, in an attempt to remake the museum archive and to understand how 3DSP data could be positioned within it.

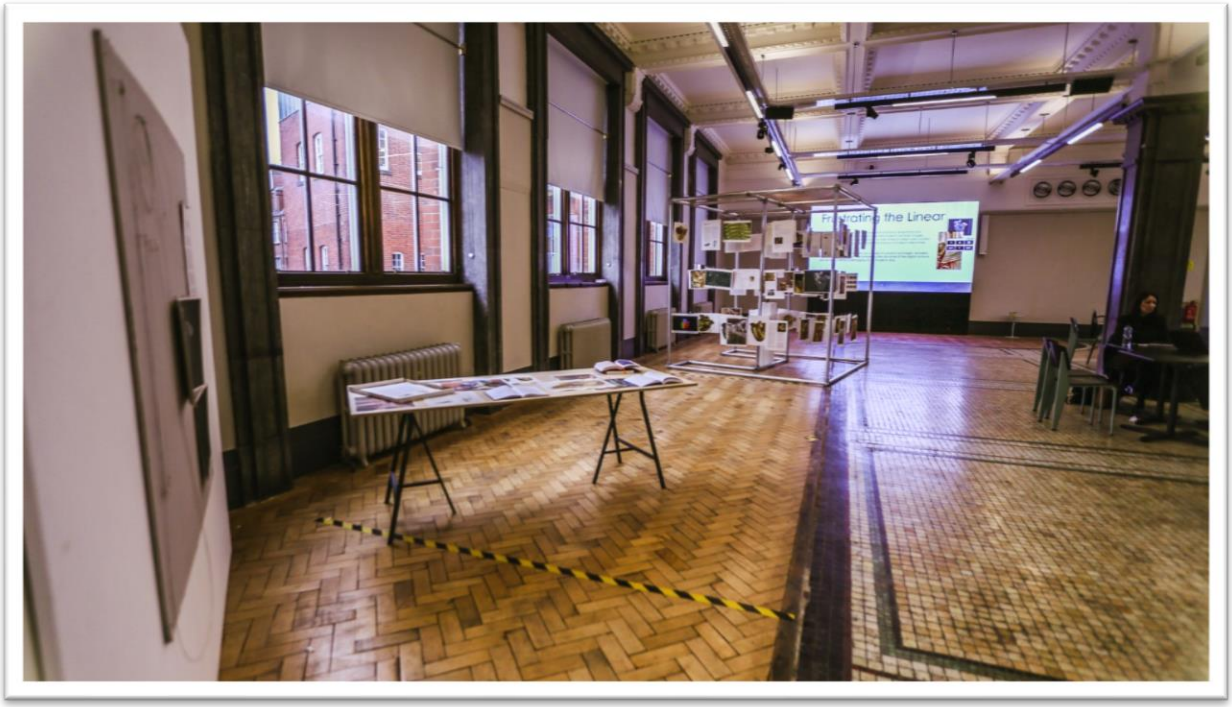


Figure 45 A photograph of the exhibition 'Frustrating the Linear'

The process helped to reveal the multiple ways in which the archive can be structured. It showed how frustrating the linear nature of the archive could be and how changing the values in which the archive was structured did not necessarily mean that it become devoid of meaning. Instead, new object relationships became evident. Data that was considered as separate, because it related to different time periods, objects or different experiments, could come together to form new ideas, not only about the objects in question but also about the archive as well.

Such a notion has the potential to move our understanding of the museum archive away from systems of ordering and object/data taxonomies to a more fluid method of object categorisation, where the polysemy of objecthood can be explored. 'Frustrating the Linear' sought to give space to 3DSP data and position it alongside historical, geographic, scientific and environmental data relating to the same museum object, providing new opportunities for connections and object understanding to emerge.

7.52 Struggling with Infrastructure

During both museum residencies, but more predominately during that of The British Museum, curators were concerned that their museums' technological infrastructure did not

meet the requirements needed to visualise and work effectively with 3DSP content. Museums Sheffield have yet to engage fully with 3DSP.

The technological requirements needed for effective engagement with 3DSP was one of curators' main concerns during the first phase of this research and remained so throughout the Museums Sheffield Residency. However, this was not the case for curators at The British Museum, who had already experienced 3DSP through the Information Services Team and external contractors.

The British Museum residency asked curators to deal directly with 3DSP and so they used the computers in their offices to view work that had already been created. Neil, Alexandra and Marie noted the difficulties they that were having viewing the scans. Alexandra would often view the 3D scan of the Nereid Monument on her phone stating that it processed the objects faster than on her work desktop. This was an action that was supported by Marie's statement from her diary writings.

'Could be a useful tool for researchers, although PC processing too slow and can't cope with data making the discovery process a slow process' (Marie – The British Museum).

Here, it is not only considerations around storage and metadata that the museum needs to consider, but also the practical aspects of effectively visualising 3DSP. Outdated operating systems, low ram and graphic capabilities affect how the 3DSP can be viewed and edited. They consequently slow the reviewing processes down. In general, museums, are not early adopters of technology, preferring to rely on, or be influenced by, historical methods of interpretation and display. Furthermore, they are limited by budgets, conservation practices and audience expectations. As a result, the immediacy of technology and the associated slowness of museological culture can be seen as juxtaposed yet in opposition to each other. It has the potential of making it seem as if the two can be difficult to integrate and to manage, especially given the speed with which technology is updated and renewed.

7.6 Conclusion

In conclusion, 3DSP's integration with the museum has a significant effect on the digital practices of the museum. Storage, data reproducibility and the legal aspects of retaining ownership of disseminated 3DSP files were key concerns for both curators at Museums Sheffield and The British Museum. Yet, at the same time, the museums' hesitancy at

disseminating some 3DSP objects online, especially those with cultural sensitivities and of nonwestern origin, can be seen as a result of the lack of 3DSP and IPR knowledge. Digitally replicating culturally sensitive objects of nonwestern descent could be seen as a form of digital colonialism, an accusation that could have significant impact on curatorial practice and the reputation of the museum.

The concern of digital colonialism was only mentioned at The British Museum, perhaps because the institution is more sensitive to issues of colonialism. The British Museum is known for its historical significance and houses a 'national' collection and its historical association with colonial acquisition practices means it is potentially more aware of the repercussions of accusation of digital colonialism. Furthermore, curators at the museum had more experience of using the technology, as well as the support of a digital team resulting in a heightened awareness of the challenges, benefits and audience response to their use of the technology. As a result, it its clear the digital implications of implementing 3DSP into museum practice are perceived far more at The British Museum than Museums Sheffield.

However, the digital implications of introducing 3DSP into the museum do not exist in isolation, they affect curatorial perception and practice. The notion of accessioning 3DSP museum objects revealed how such objects do not conform to current categorising systems embedded within the museum database and how created a new form of curatorial thinking. The same curatorial thinking is also noted in the curatorial understanding of the 3D scan and the 2D image.

A common thread throughout the data relating to 3DSP's impact on the digital aspect of the museum was how curators and senior management worked to manipulate the integration of 3DSP to best serve how they perceived 3DSP working within the museum. The actions of both senior management and curators have the potential to work with each other or against depending on the collection and object in question.

8. Conclusion, Contributions, Limitations and Recommendations

8.1 Introduction

In this thesis I have researched and examined how and why 3DSP affects the museum from the perspective of curators. In doing so I have identified the challenges and benefits that 3DSP bring to the museum and the perceived role the processed scan and print has within the museum. The methods used to research this topic have revealed not only how the use of curatorial methods can contribute to cultural heritage studies, but also how 3DSP can be considered as a valuable tool for opening up the collection and the systems of categorising within the museum.

3DSP has the potential to bring a new form of play to curatorial practice while simultaneously encouraging curators to stop, touch and investigate their objects, breaking down the systems of ordering and providing new object insights. Yet, at the same time, the methods used within this research reveal the concerns that curators and those in senior non-curatorial positions have about the legal rights and technological requirements associated with the integration of 3DSP.

Below I have detailed the considerations that should be taken into account when integrating 3DSP into the museum and the effect that such an integration could have on the curatorial role. At the beginning of this thesis, I proposed the following research question:

> *How does 3D scanning and printing affect museum practice and tradition from a curatorial perspective?*

This research question was designed to respond to gaps in literature and knowledge identified in Ch.2 'A Contextual Review'. Its aim was to investigate how the emergence and integration of 3DSP was impacting on the role of the curator and how curators perceived the effect of this technology on their practice. As mentioned in Ch.2, the use of 3DSP within the museum is of keen interest to museum practitioners and professionals (Matello and Rossi 2011), yet the majority of literature concerning its use in the museum consists of articles detailing only the processes of use. As a result, very little is known about how museum professionals, particularly curators, who are the first and primary people to interact with objects, see the use of 3DSP as affecting their practice.

In order to address the given research question and the gaps, in knowledge I formulated the following objectives in association with the aims documented in Ch.1 'Introduction':

- To draw on literature from curation, museology and 3DSP technology in order to form an account of where 3DSP processes sit in relation to audience, practice and policy.
- To establish residencies with 2 different museums that were already dealing with 3DSP and that had different scales, curatorial structures, relationships to policy, etc.
- To devise and undertake a series of experimental methods with curators, using existing curatorial processes to capture directly the relationship between original object, scan and 3D print.
- To generate a series of artefacts and documented experiments that articulate the relationship between the curator and the artefact.

To address and meet these objectives I adopted a practice-based approach, using a combination of curatorial based methods, in an attempt to gain insights to how the curators participating in this research would perceive the integration, role and effect of 3DSP on their practice.

8.2 Contributions

The main contribution of this thesis is the understanding of how curators perceive 3DSP in the museum. Curators across Museums Sheffield and The British Museum saw 3DSP as a tool for enriching the audience experience, as well as their own practice. However, they struggled to see where 3DSP sat within the museum or whether the objects and scans produced from this technology should be a part of the museum collection. This research sought to ascertain the curatorial perception of 3DSP technology and objects within the museum. Yet given that the curator does not exist in isolation, it also offered some insights into how 3DSP impacts on wider museum practice. The subsequent sections in this chapter (8.21- 8.23), list the study's contributions to knowledge.

8.21 The integration of 3DSP

The study provides insight into the motivation to integrate 3DSP within the museum, as well as the barriers. In regard to the motivations, curators across Museums Sheffield and The British Museum saw 3DSP as a tool for enriching the audience experience, as well as their own practice. From a 'front of house' perspective, this is an acknowledgement that 3DSP can

support audience engagement, object handling and outward facing museological strategies. Yet, perhaps more significantly, curators wanted to use 3D to play with their collection and re-actualise their objects. It shows how curators at both museums could enrich their own practice and bring a more experimental approach to object understanding.

However, as mentioned above, the integration of 3DSP is not without contention. Both curators and non-curatorial members of staff at both museums struggled to position 3DSP and the objects it produced within the context of the museum collection. They cited the materiality of the objects as problematic but, embedded within this, are complex and interlinking perceptions around the aesthetic language of 3DSP, the traditions of the museum and preconceived assumptions about 3DSP. As such, the barriers to the integration of 3DSP in the museum are not confined to a single entity, but are part of a complex and interlinked system of perceptions and practice. It is important to mention that these barriers are not fixed and will likely change and shift as the technology and understanding develops.

8.22 Curatorial understanding of 3DSP

The second contribution this Ph.D. brings to knowledge is how curators perceived the use of 3DSP within their practice. The methods used to undertake this research allowed curators to engage with technology. Through curatorial making and that of using 3DSP as a form of play curators were able to see how 3DSP can benefit but also challenge their practice.

Throughout the research phases there was focus on whether 3DSP museum objects challenged the authenticity of actual museum objects and consequently the authority of the museum. For example, curators at The British Museum wanted their objects printed as accurately as possible, with concerns over false data added during the post-processing phase.

8.23 Developing curatorial practice through the use 3DSP.

The third contribution of the study involves creating insight that can, potentially, change and develop curatorial practice through the use of 3DSP. By using the technology as both the subject of the study and also as the means of investigation, the practices of curators were made visible, consequently, revealing systems of hierarchical value and knowledge transformations. The methods used within this study present a novel approach to researching in the museum setting. The value of such an approach is that it allowed the practices of the museum to be turned in on itself, consequently challenging and frustrating the traditional forms of practice, to reveal sites of tension and enrichment for curators to reflect upon.

The study showed how curators across both museums struggled to position 3DSP within the context of their practice and collection. While this is a statement about the position of 3DSP it is also one about how contemporary museum practice is not structured to accommodate 3DSP. The technology's origins in mass production, combined with the materiality of the objects it produces and the traditions of the museum, frustrate the cataloguing practices of such cultural institutions. As mentioned in Ch.7 'The Digital and the Museum', 3DSP objects are neither part of the museum nor completely separate from it, and thus if the museum and its curator are to take advantage of the benefits of 3DSP, such as enriching audience engagement and outreach strategies, there is a need to modify the rigid structures of the museum.

8.24 Using exhibitions a research strategy

The fourth contribution of this study is the contribution of the 3 exhibitions and how positioning them as a research strategy helped to answer the questions embedded within the research. The co-curation of the first exhibition, Stories from the East: The Grice Ivories, revealed sites of tension and perceived boundaries about the setting of 3DSP within the gallery. By using the curation of the exhibition as a site of research, I was able to experiment with space and layout revealing how particular object properties impacted on the curatorial perception. The exhibition served as a real-world situation in which to research in; as a researcher I was able to generate concepts, test ideas and challenge curators through the co-curation of the exhibition.

The curation of the second exhibition 'An Object in Transition' was developed from the data collected from The British Museum residency. The exhibition sought to visualise how the 3DSP process changed objects as they moved through the museum space. The contribution of the exhibition was in its visualisation of the 3DSP process and its positioning of this process alongside quotes from curators. It challenged audiences and myself to think about not only what a museum object could be but also reflect upon the wider impact of 3DSP in the museum such as potential accusations of digital colonialism.

The final exhibition, 'Frustrating the Linear', contribution to this study was that it allowed me to experiment with ideas around data categorisation and the system which museums use to order data. The exhibition took the form of a performance piece in which the act of taking down and re-hanging the work was a mode of research. By layering new and old pieces of

information relating to the Ringlemere Cup I was able to challenge the traditional ways in which museums structure and collect data as well as, perceive new object relationship through the data. The exhibition revealed insights into how the documentation of 3DSP objects impacts our understanding of the objects value in the museum as well as exposed more of the object's polysemy.

All three exhibition have helped to answer questions and reveal new insights into how 3DSP impacts on museum practice from the perspective of the curator. The use of exhibition making as a research strategy provides a platform to examine, manipulate and perceive datasets in new ways, consequently providing multiple angles into how 3DSP affects the practices of the museum.

8.3 Summary of Conclusions

This section of the chapter is a summary of the overall research. The conclusions outlined at the end of each of the discussion chapters summarise in detail, within the context of the chapter theme, the challenges, benefits, implications and impact of 3DSP as perceived by curators.

The title of this study is framed around the notion of 'insecurity'. This is a complex term that encompasses many of the concepts explored in the discussion chapters of this thesis. The use of the word insecurity is a reflection on how 3DSP challenges the borders and systems of 3DSP, it pulls at both the value and hierarchal systems of authority, and makes us think about the lines that separate collections. As Neil from The British Museum notes the technology and its accompanying visualisation tools allow us to view multiple 3D scans without the definitions of separate collections. 3DSP is developing at such a rate that museums cannot keep pace. Museums have concerns about how to secure 3D datasets for the future, there are complex discussions around data storage, reproducibility and version control, this combined with the fact that the full limits of 3DSP have yet to be realised means it is only natural for the museum to feel unsure of how to progress with the technology.

The use of 3DSP is also a concern for current curators, who no longer feel secure the in definition and future of their roles. As digital projects start and end, the curator is more and more finding themselves with files and datasets they do not understand. These digital projects

innovative while great for audience engagement, outreach and research can take the curator way from what historically sat at the heart of their role: the object.

I will now outline how I believe I have answered the research questions with reference to the Aims outlined in Ch.1 'Introduction'.

With reference to the first *aim (To understand the motivations and barriers surrounding the integration of 3DSP into the museum environment),* I have designed methods that sought to make visible the challenge of integrating 3DSP into museum practice. This study has worked with real-world 3DSP projects, with the aim of provoking a curatorial response to the museological policies and practice that either act as hindrance or advancement for the use of 3DSP within the museum.

This study has revealed how curators perceive the material and immaterial properties of 3D scanned and printed objects and the logistical barriers of integrating 3DSP into museum practice as well as revealing their desires to play and experiment with the technology.

In relation to the second aim *(To explore how curators perceive the physical and immaterial properties of 3DSP).* I have analysed how curators perceive different materials and aesthetic properties of 3DSP objects within the context of museum practice and curation. This consequently reveals how perceptions of 3DSP objects were influenced by the desire to retain accuracy and conform to the message of the museum.

To do this, I reinterpreted the tripartite curatorial process, providing curators with the opportunity to respond to the properties of 3DSP through methods and language similar to that used in their everyday practice. Furthermore, I have actively tried to engage curators in the making processes of 3D scanning, giving them the opportunities to experience and understand how museum objects transform and aesthetically transition through the 3DSP process.

In reference to the third aim (*To explore how curators' perceptions of making and using 3DSP impact on the value of the print and the understanding of the original artefact in the museum),* I have, worked to engage curators actively in the 3D scanning process. Over the course of the Ph.D. research, curators have taken part in the 3D scanning process and observed and commented on the processing and printing. I have situated 3DSP within the context of the

museum and the exhibition, allowing curators to see how the 3DSP object is similar and different from the original museum object within the confines of their practice.

The methods used in this research have allowed for perceived familial relationships to emerge between the museum object and the 3DSP replica. This consequently situated 3DSP objects within the realm of the museum collection and challenged traditional notions of categorisation and ordering.

The fourth aim of this study *(To ascertain how curators' understanding and responses to 3DSP may be framed by and affect the regional national and international museum context.)* was met by ascertaining curatorial perceptions from real-world 3DSP projects. By working with current in house 3DSP projects over a prolonged period of time, I was able to determine how 3DSP is perceived in relation to the context of the museum, its departmental structures and daily practices.

This study has shown how the reputation and resources of the museum affect how 3DSP is used and perceived within the museum. External factors such as copyright and audience expectation impacted on the way curators devised and commented on their 3DSP projects, especially in the case the national museum.

Finally, and in regard to the fifth aim of this study*, (To enable curators to reflect on their role and the impact that 3DSP has on their individual way of curating their collection),* my prolonged presence in the museum, combined with this study's approach of turning the museum's practices in on themselves, allowed curators to develop a reflective insight into their practice.

This study's approach of examining current, in house 3DSP projects provided curators with the opportunity to critique and reflect upon the development of each project as it transitioned through different museum departments. Curators were able to use 3DSP, their diary pages and the act of curating with the technology, to comment upon the changing role of the curator, new forms of curatorial practice and the impact technology could have on the museum.

8.4 Limitations

The limitations of this thesis are reflected in the scope and chosen methods of this study. The main limitation of the focus on two museum sites. I used my time and resources to develop a

strong relationship with two museum communities which prevented the study having a broader scope. This is significant, as museums are not representative of each other and it can be argued the results of this study only relate to the museums they originated from. With more time and resources, I would like to expand this study to include more museums and develop a boarder understanding of how 3DSP impacts on the cultural sector.

Another limitation of this study this that it only focused on 3D scanning and printing. This decision was made because 3DSP is an innovative and technology which is being rapidly adopted by museums. Yet, the decision to focus on 3DSP negates other forms of additive manufacturing, which could be of used within museum practice. As a potential development to this study, I would like to expand the scope of my focus to include alternate forms of additive manufacturing. This hypotheses for this being understanding how multiple forms of technology can be used within museum practice, has the potential to enhance and diversify curatorial museum practice.

The other significant limitation of this study is that it did not focus or take into account audiences' perception of 3DSP. The audience voice in regards to 3DSP is included in the numerous studies but an in-depth study to how they perceive the benefits of using 3DSP has yet to be conducted. As a developed to this study I would like to interview museums audiences potentially children as 3DSP is often used in museum education activities.

8.5 Recommendations

The results of this study have revealed the integration of 3DSP into the museum environment a complex and divisive issue. In the final section of this study I would like to directly write to any museum professionals reading this study. The applications of 3DSP can be greatly beneficial to museum practice but like all new technology, its introduction is not without challenges. In order to negate some of these challenges I would like to outline some recommendations.

- The logistics around introducing 3DSP are complex and it is important to consider how the data produced from scanning will be stored and documented. The decisions one makes for documenting such objects will have a lasting impression on how these objects are perceived.

- In order to negate some of issues of integrating 3DSP into museum practice it is important provide some sort of training programme that will allow curators and other museum staff to use the and apply the technology effectively.
- The undervaluing of the museum curator is a key issue in our current cultural environment There is a need to recognise the value curators bring to the museum collection as well as provide support for their changing role, especially in our ever-increasing digital world.

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Appendix A: The Acclimatisation Study

Appendix A1

Participant Information Sheet for Museums Sheffield (Acclimatisation Study)

Research Organisation:

Cultural Communication and Computing Research Institute
Sheffield Hallam University
City Campus,
Howard Street,
Sheffield
S1 1WB,
UK

Researcher Contact Information:

Should you have any questions concerning this research please feel free to contact the researcher (Amelia Knowlson) at amelia.l.knowlson@student.shu.ac.uk / 0114 225 4680

Project Title and Duration

3D scanning and printing Sheffield Museums' Collections
February to April 2016 (Subject to consultation with Sheffield Museums)

Project Outline

The research proposed will act as An Acclimatisation study to test, examine and ascertain different forms of 3D scanning and printing methods for historical museum objects. The primary aim of this pilot is to test the limitations of various 3D technologies and the perceptions of curators at Museums Sheffield, the results of which will act as a precursor to scanning and printing activities in further museum-based research. During this research this project will use a range of different 3D scanners, in order to ascertain how each scan captures or loses detail.

The project will 3D scan and print objects from the Archaeological, Ivory/Metalwork and World Cultures collections. In order to do this I will need to be based in the museum for 2 to 3 days a week with access to the museum objects. The selection of the objects shall be made jointly with the researcher and museum curators allowing conversations surrounding appropriateness, histories, values and languages to be explored. Selected objects will be scanned and printed in a range of different 3D printing and post-production methods. The aim of this research is to create both accurate and degraded objects in a bid to understand how detail which is lost or gained in the 3D scanning and printing process affects visual and communicative interpretations.

Participants Rights and Roles

Sheffield Museums has been invited to take part in this research as a regional museum partnership with an interest and experience in using 3D scanning and printing techniques in collection access and research. Participation in this research is voluntary, will not incur the museum any costs and the museum has the right to refuse and withdraw consent at any time. Withdrawing from this research once consent has been given will not affect the museum in any way.

Health and Safety

This research does not cause harm or damage to the objects which are to be 3D scanned, 3D scanning is a non-contact, non-invasive method of capturing surface data. The actual 3D scanning will be done by the researcher (Amelia Knowlson). In accordance with any insurance and object protocols museum staff may observe the 3D scanning process and oversee the moving and handling of objects.

Museum staff observing and conducting object handling and moving must adhere to the health and safety requirements of working with 3D scanners. Although working with 3D scanners is not dangerous, it is advised to remain behind the scanner at all times as the structured laser light can cause irritation to the eyes if looked directly into.

Confidentiality and Anonymity

The individual levels of confidentiality and anonymity requested by each participant will be respected and maintained throughout the duration of this research. Field notes will not be made public and only shared with the consenting individual who originally gave them. Notes and digital models generated as part of this research will be stored in a secure password protected hard drive and university research drive. The original notes will be stored separately in a locked drawer with only the researcher having access. Field notes will be pseudonymised to ensure that no one other than the researcher can read them.

Data (3D models and unrendered files) will be stored for the duration of the project plus 3 years. This is to comply with any requests for information and to disseminate findings, in accordance with the anonymity of participants, through publications. This research will respect the views, wishes and ideas expressed during the research period and not discuss findings and views with anyone outside the research team.

Funding

This research is funded by The Arts and Humanities Research Council and hosted by Sheffield Hallam University.

Appendix A2

Informed Consent for Museums Sheffield (Acclimatisation Study).

Dear Participant

Thank you for your interest in this Acclimatisation study research as part of a PhD aiming to understand how and why 3D printing impacts museum environments. The research proposed will act as an initial study to test, examine and ascertain different forms of 3D scanning and printing methods for historical museum objects. The primary aim of this study is to ascertain the limitations of various 3D technologies and the perceptions of curators in regard to 3D scanning and printing. The results of which will act as a precursor to scanning and printing activities in further museum-based research.

This form defines how your participation within this research will be used. Kindly read and sign this form indicating that you understand and accept the conditions of this research.

Your participation will involve selecting 1-4 objects with the researcher from the Archaeological, Ivory/Metalwork and World Cultures collections to be 3D scanned. Discussions around the selection of the objects will not be recorded, although field notes will be taken. The researcher would be grateful if you would allow your name to be used within the main body of work; however, there is the option to anonymise yourself. Quotes and views will be used for academic purposes, such as the thesis, presentations and articles. With your permission, photographs of the objects and scanning process will also be taken.

With your consent, your role and affiliation within your organisation will be presented within this research. Field notes will not be made public and only shared between yourself and the researcher. Notes and digital models generated, as part of this research, will be stored on a secure password protected hard drive and university research drive. The original notes will be stored separately in a locked draw with only the researcher having access.

Please circle below your preferred choice of anonymity:
Whatever form of anonymity you chose, the researcher will respect the decision and ensure it is upheld throughout the research. You have the right to withdraw consent from this research at any time. Withdrawing your consent will not hinder or cause any ramifications to you or your organisation.

I do/do not give consent for notes and observations of this pilot study to be used as research for the above study.

I do/ do not give consent for my name to be used within the study.

I do/do not give consent for the name of institution that work to be used with the study.

Please sign and date this form to show that you fully understand the Informed Consent Form and accept its conditions

Participant Name: Date

Participant Signature:

Researcher Name: Date

Researcher Signature

Appendix B: The Museum Sheffield Residency

Appendix B1

Participant Information Sheet (The Museums Sheffield Residency)

Research Organisation:

Cultural Communication and Computing Research Institute
Sheffield Hallam University
City Campus,
Howard Street,
Sheffield
S1 1WB,
UK

Researcher Contact Information:

Should you have any questions concerning this research please feel free to contact Amelia Knowlson (amelia.l.knowlson@student.shu.ac.uk)

Project Title and Duration and Event Type
The Printed Museum: 3D printings effect on museum policy, practice and audience

Project Outline

'The Printed Museum' is a PhD project undertaken by Amelia Knowlson, it examines how and why 3D printing affects the museum as an institution and its practice and audiences. My research follows the curatorial process to establish how 3D printing is perceived. During the residency, I am undertaking with you, I will be observing how 3D scanned and printed objects are being used on a daily basis. My observations will be recorded in a diary and will not be shared with anyone outside the project. I will also be staging a series of museum interventions that are designed to follow the curatorial process and explore how 3D scanning and printing is understood within the museum. The interventions are as follows:

- **Accession a 3D printed museum object**
  The aim of this is not to assess your skills of accessioning, but to establish how they form meaning around the object. The accessioning intervention is expected to take 30-45 mins and will be written on the researcher's laptop. Modes complete will be used to accession the 3D printed object created during the residency.

- **Document a 3D printed museum object**
  The purpose of this intervention is to explore how you communicate 3D printed museum objects to audiences. You will be able to use your accession record as a guide and the label

can be created on your own computer. The length of this label is up to you but must be within the museum's guidelines.

- **Create a display concept using a 3D printed museum object.**
  This intervention will explore how you see 3D printed and scanned objects being displayed in museums. Ideally the display concept would be physical but it can be 2D if need be and materials will be provided to support this intervention.

Participants Rights and Roles

Your participation in this research is voluntary, will not incur you or your institution any costs and you have the right to refuse and withdraw consent at any time. Withdrawing from this research once consent has been given will not affect you in any way.

Health and Safety

My project and the interviews within it do not cover any difficult or emotive topics and will not cause your any physical or emotion harm.

Confidentiality and Anonymity

The individual levels of confidentiality and anonymity requested by each participant will be respected and maintained throughout the duration of this research. Photographs, quotations and notes will not be made public and only shared with the consenting individual who originally gave them. Notes and digital models generated as part of this research will be stored in a secure password protected hard drive and university research drive. The original notes will be stored separately in a locked drawer with only the researcher having access. Field notes will be pseudonymised (unless permission to do otherwise has been granted) to ensure that no one other than the researcher can read them.

Data will be stored for the duration of the project plus 3 years. This is to comply with any requests for information and to disseminate findings, in accordance with the anonymity of participants, through publications. This research will respect the views, wishes and ideas expressed during the research period and not discuss findings and views with anyone outside the research team.

Funding

This project is funded by The Arts and Humanities Research Council (AHRC) and is hosted by Sheffield Hallam University

Appendix B2

Informed Consent (The Museums Sheffield Residency)

Dear Participant

Thank you for your interest in this research as part of a PhD aiming to understand how and why 3D printing impacts museum environments. As part of the residency I am undertaking with you I am staging a series of interventions that follow the curatorial process that are designed to explore how 3D printed and scanned objects are perceived.

This form defines how your participation within this research will be used. Kindly read and sign this form indicating that you understand and accept the conditions of this research.

Your participation will involve participating in a series of interventions (please see participant information sheet). These interventions are not designed to test you in any way but explore to how you perceive 3D technologies and the objects they produce in relation to your practice and collection. You will be briefed at the start and end of each intervention and once all three have been completed a short informal focus group will be staged in order to discuss your perceptions. During the focus group I (Amelia Knowlson) will take notes and an audio recording will be taken. The researcher would be grateful if you would allow your name to be used within the made body of work; however, there is the option to anonymise yourself. Quotes and views will be used for academic purposes, such as the thesis, presentations and articles. With your permission, photographs of the objects and scanning process will also be taken.

With your consent, your role and affiliation within your organisation will be presented within this research. Field notes will not be made public and only shared between yourself and the researcher. Notes and digital models generated, as part of this research, will be stored on a secure password protected hard drive and university research drive. The original notes will be stored separately in a locked drawer with only the researcher having access.

Please circle below your preferred choice of anonymity:
Whatever form of anonymity you choose the researcher will respect the decision and ensure it is upheld throughout the research. You have the right to withdraw consent from this research at any time. Withdrawing your consent will not hinder or cause any ramifications to you or your organisation.

I do/do not give consent for notes and observations of this pilot study to be used as research for the above study.

I do/ do not give consent for my name to be used within the study.

I do/do not give consent for the name of institution that work to be used with the study.

Please sign and date this form to show that you fully understand the Informed Consent Form and accept its conditions

Participant Name: Date

Participant Signature:

Researcher Name: Date

Researcher Signature

Appendix C: The British Museum Residency

Appendix C1

Participant Information Sheet (The British Museum Residency)

Research Organisation:

Cultural Communication and Computing Research Institute
Sheffield Hallam University
City Campus,
Howard Street,
Sheffield
S1 1WB,
UK

Researcher Contact Information:

Should you have any questions concerning this research please feel free to contact Amelia Knowlson (amelia.l.knowlson@student.shu.ac.uk)

Project Title and Duration and Event Type
The Printed Museum: 3D printings' effect on museum policy, practice and audience

Project Outline

'The Printed Museum' is a PhD project undertaken by Amelia Knowlson, it examines how and why 3D printing effects the museum as an institution and its audiences. During the residency, I am undertaking with you, I will be observing how 3D scanned and printed objects are being used on a daily basis. My observations will be recorded in a diary and will not be shared with anyone outside the project. I will also be staging a series of museum interventions that are designed to explore how 3D scanning and printing is understood within the museum. The interventions are as follows:

- 2 flow charts detailing the decision-making process for a 3D scanning and printing project

- A series of questions around the use and reception of 3D scanning printing at The British Museum

- Diary pages for you to document your thoughts, ideas and questions about 3D scanning and printing.

Participants Rights and Roles

Your participation in this research is voluntary, will not incur you or your institution any costs and you have the right to refuse and withdraw consent at any time. Withdrawing from this research once consent has been given will not affect you in any way.

Health and Safety

My project and the interviews within it do not cover any difficult or emotive topics and will not cause you any physical or emotion harm.

Confidentiality and Anonymity

The individual levels of confidentiality and anonymity requested by each participant will be respected and maintained throughout the duration of this research. Photographs, quotations and notes will not be made public and only shared with the consenting individual who originally gave them. Notes and digital models generated as part of this research will be stored in a secure password protected hard drive and university research drive. The original notes will be stored separately in a locked drawer with only the researcher having access. Field notes will be pseudonymised (unless permission to do otherwise has been granted) to ensure that no one other than the researcher can read them.

Data will be stored for the duration of the project plus 3 years to comply with any requests for information and to disseminate findings, in accordance with the anonymity of participants, through publications. This research will respect the views, wishes and ideas expressed during the research period and not discuss findings and views with anyone outside the research team.

Funding

This project is funded by The Arts and Humanities Research Council (AHRC) and is hosted by Sheffield Hallam University.

Appendix C2

Informed Consent (The British Museum Residency)

Dear Participant

Thank you for your interest in this research. This study is part of a PhD aiming to understand how and why 3D printing impacts museum environments. As part of the residency I am undertaking with you I am staging a series of tasks that explore how 3D printed and scanned objects are perceived.

This form defines how your participation within this research will be used. Kindly read and sign this form indicating that you understand and accept the conditions of this research.

Your participation will involve participating in a series of tasks (please see participant information sheet). These tasks are not designed to test you in any way but to explore how you perceive 3D technologies and the objects they produce in relation to your practice and collection. You will be briefed at the start and end of each task and once all three have been completed a short informal focus group will be staged in order to discuss your perceptions. During the focus group I (Amelia Knowlson) will take notes and an audio recording will be taken. The researcher would be grateful if you would allow your name to be used within the main body of work; however, there is the option to anonymise yourself. Quotes and views will be used for academic purposes, such as the thesis, presentations and articles. With your permission, photographs of the objects and scanning process will also be taken.

With your consent, your role and affiliation within your organisation will be presented within this research. Field notes will not be made public and only shared between yourself and the researcher. Notes and digital models generated, as part of this research, will be stored on a secure password protected hard drive and university research drive. The original notes will be stored separately in a locked drawer with only the researcher having access.

Please circle below your preferred choice of anonymity:
Whatever form of anonymity you choose the researcher will respect the decision and ensure it is upheld throughout the research. You have the right to withdraw consent from this research at any time. Withdrawing your consent will not hinder or cause any ramifications to you or your organisation

I do/do not give consent for notes and observations of this pilot study to be used as research for the above study.

I do/ do not give consent for my name to be used within the study.

I do/do not give consent for the name of institution that work to be used with the study.

Please sign and date this form to show that you fully understand the Informed Consent Form and accept its conditions

Participant Name: Date

Participant Signature:

Researcher Name: Date

Researcher Signature