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Museum replicas: second-rate copies or valuable resource?

Introduction

Casts and replicas of museum objects are powerful tools in experience-based education. However, they are not always given as much appreciation as they are due. Since the heyday of museum and university cast collections in the eighteenth and nineteenth centuries, the status of replications within cultural institutions has been on a roller-coaster ride, guided by theories surrounding authenticity and originality. Most recently, the development of publicly available 3D modelling software and small-scale 3D printing apparatus has driven a revitalisation of museum-based replication, both for aesthetic and educational purposes. However, not all replicas are made equal, nor are all educational programs based around them. Understanding the history and mechanics of replication techniques, like plaster casts and 3D prints, helps institutions develop programs that play to their strengths and create a favourable learning environment.

For the sake of clarity, I have chosen to focus on physical replication, so this paper will not go into any depth on photo replication or any other form of virtual imaging, save where they are used specifically as models for physical replication. These forms of replication bring with them their own set of complications and these have been written about extensively elsewhere.[1] I also make a distinction

1 This subject has been extensively discussed in Callery 2004; McTavish 2006; Parry 2010. It has also received its fair share of media attention as in Katyal and Ross 2016, 1 May; Lufkin 2016, 10 May; Miranda 2013, 13 May.

between plaster casting and other forms of, and materials for, replication.[2] As casting has its own particular method and history, it will form the primary focus of my analysis and will often be identified separately, but I will also delve into more modern methods—primarily 3D printing. I do not extend my argument to fakes and forgeries. The replicas I refer to are not created with the intention to deceive, but rather are identified as being 'other' than the works to which they refer.[3]

In this article I will delve into the complexities of replica creation, collection and display, particularly in the context of university museums. I will first give an outline of the history of casts created for museological purposes. I will then briefly discuss the concept of authenticity as it relates to the replication process and the existence of casts or replicas as both copies and originals. Next, I will look at how 3D modelling and printing has altered the casting debate. Finally, I will illustrate the roles that these collections can play in teaching ancient world studies within academic and public institutions. Ultimately I hope to show the benefits of using casts and replicas for a wide range of educational purposes.

Cast collecting through time

While most cast collections that exist today date to the eighteenth and nineteenth centuries,[4] the practice actually dates back much further, with the earliest evidence of collecting dating back to antiquity. The remains of plaster casts found in the Roman spa town of Baiae on the Gulf of Naples provide the greatest single store of evidence on casting in the ancient world.[5] The evidence consists of 430 fragments of larger sculpture casts.[6] The casts were found in a secondary

2 See Craddock (2009) for a description of the technique of plaster casting.

3 In this I follow Alfred Lessing (2008) in his definition of the term forgery as 'involving deliberate deception', 94.

4 See for example the Victoria and Albert Museum's Cast Collection, dating back to the museum's founding in 1852 (Baker 1982). Its specially designated Cast Court, opened in 1873, was refurbished recently (2012–14) and still forms one of the museum's most prized exhibitions (Sharpe 2014).

5 Anguissola 2015, 252.

6 Landwehr 1985, 177–80.

context, namely in a cellar pit under the Baths of Sosandra.[7] Christa Landwehr identified many of these casts as being consistent with the forms of twenty-four to thirty-three well-known Classical bronzes, specifically those made in fourth- and fifth-century Greece.[8] This suggests the presence of a sculpting workshop nearby providing copies of Greek statues, in marble or possibly other materials, to the Roman population who avidly collected such adornments to showcase their wealth and good taste.[9] The casts assembled by the workshop could then serve as a 'library of form', that the artisans could consult in preparing their reproductions.[10] This ability for artisans to consult casts of originals cemented their expertise in Greek-style sculpture and ensured the quality of each piece emerging from the workshop, without requiring access for each artisan to the original pieces. However, it is significant that none of these end products were exact copies of the originals and their casts. Each work bears slight variety in detail.[11] This variety highlights the role of these pieces not just as Greek copies, but as pieces of Roman art.[12]

These Greco-Roman casts, though not a cast collection in the sense of an independent artistic exhibition, do indicate an important element of the later collecting tradition, namely their function as a resource for study and further artistic creation. This becomes exceedingly important in later revivals of ancient aesthetics. Taking a leap forward in time from the Greco-Roman period to the early Renaissance, we see the importance of casts re-emerging, this time alongside the reproductive method of printing, made prominent by the increasing access to paper.[13] These copies could be used as sources of study, or as prestige items in their own right, and it was a sign of nobility to have a collection of classical copies in one's palace, though these would often be preserved in more durable materials

7 Anguissola 2015, 252.
8 Landwehr 1985, 185–8; Landwehr 2010, 35.
9 A possible life cycle for the workshop is proposed in Gasparri 1995, 184–7.
10 Frederiksen 2010, 20.
11 Christa Landwehr uses Roman copies of Aristogeiton to highlight these singularities in detail in her original work on the collection (1985, 27–34).
12 Hallett 1995, 123.
13 Paper came to Europe from China and by way of the Islamic World (Griffiths 1996, 16).

such as marble or bronze. Thus, Francesco Primaticcio was commissioned in the 1540s by King Francis I to take casts of the major works in the Vatican collection at Rome, in order to create a collection of bronzes for the king's new palace at Fontainebleu.[14] The moulds were ultimately sent as a gift to the Habsburgs in the Netherlands in an attempt to cement a treaty, from which they were passed on to sculptor Leone Leoni in Milan.[15] Using these casts he was able to create a number of sculptures for the gardens of Mary of Hungary's *château* at Binche.[16] Leone Leoni kept these casts in his villa and his own collection is described by Giorgio Vasari upon his visit to the sculptor's home in Milan.[17] His collection was looked upon as something that proved his status as a gentleman, and even elevated it, through the collection's extent and quality.[18] This renaissance tradition of cast collecting for sculptors, as display pieces and models, also extended to one's own works. Eckart Marchand discusses the role of such collections as a method of 'retaining artistic solutions within a workshop, and … disseminating these ideas to other artists'.[19] These examples show that the practice of collecting and disseminating plaster casts was already well-established and influential during the Renaissance.

Though these early instances of cast collecting were very important for the establishment of the significance of plaster casts, the period most associated with the plaster cast collections began with the rise of public collections in universities, academies and museums, reaching its peak in the eighteenth and nineteenth centuries, when the reach of plaster casts extended beyond private collections and workshops. These public *gypsotheques*, or cast museums, much like their predecessors had the function of either instructing or impressing their audiences. Art academies were especially receptive to cast collections. Formal

14 Pressouyre 1969.
15 Boucher 1981, 24–5.
16 Cupperi 2010, 82–3.
17 Vasari 1915, 232. He also decorated the façade of his villa with replicas of classical structure as described in the same Vasari fragment and Mezzatesta (1985).
18 Di Dio 2008, 153.
19 Marchand 2007, 191.

artistic training at such academies involved a great deal of copy work; studying, drawing and sculpting the works of the classical age and of the great masters of the Renaissance.[20] The French Academy in Rome was one of the best known cast collectors. Its collection emerged in 1666 after a commission by Louis XIV of France to provide copies of the major Italian works for his palace in Versailles.[21] Already in the 1680s the French Academy was sending casts to The Hague Academy, creating a network of trade among academies for casts of great artworks.[22] In the early nineteenth century French workshops and academies would still be the key exporters of casts, but now to American institutions like the Pennsylvania Academy of Fine Arts.[23]

Institutions not centred around the fine arts also engaged in the trend of cast collection for educational purposes, and they were strongly embedded within the

Figure 1: Cast Hall, image from PAFA's website.
Courtesy of the Pennsylvania Academy of the Fine Arts, Philadelphia.

20 Siapkas and Sjögren 2014, 96.
21 Haskell and Penny 1982, 79.
22 Haskell and Penny 1982, 79.
23 Henderson 1911, 14.

existing exchanges. Within universities, the acquisition of cast collections could aid in teaching art history, archaeology and classics. One of the first to obtain a substantial collection was Göttingen University's Archaeological Institute led by Ancient Studies lecturer, Christian Gottlob Heyne, in the latter half of the eighteenth century.[24] A few decades later some of the first museums established collections. According to Ursula Wokoeck, Das Akademische Kunstmuseum in Bonn was the first to establish an extensive cast collection, due to the confiscation of its regular collection during the Napoleonic Wars.[25] In her words, these collections did not just provide an educational opportunity, but also 'an aesthetic experience', both in its pure white form and the extended display possibilities that such pieces allow.[26] Beyond these functions, the plaster cast collections also served a nationalistic purpose, in elevating the taste of its people and thus the prestige of its institutions.[27] The cast collection trend also extended to the Americas and became the core of many early museum collections, allowing locals to create an impression of ancient history despite being so distant from its heartland near the Mediterranean Sea.[28] The Metropolitan Museum even developed its own moulding department in the 1890s to accommodate for the creation of plaster casts for its exhibition and teaching collection.[29] However, it was not long after these developments that debates began to kick up about the proper place of 'cheap' reproductions within the museum.[30]

In the late nineteenth century, interest in cast collecting began to taper off. This was caused primarily by the popularisation of other reproductive technologies in particular photography, which had undergone rapid development throughout the preceding century. Further undermining the role of plaster casts for study of ancient sculpture was the increasing access to originals through developments

24 Plesker 2006.
25 Wokoeck 2009, 154.
26 Wokoeck 2009, 154.
27 Schreiter 2014.
28 For more information see McNutt 1990; Dyson 1998; Born 2002.
29 Wallach 1998, 49.
30 Wallach 1998, 51.

in international travel. Within artistic circles, the turn of the century marked the dawn of a new aesthetic ideal that focused on authenticity and departed from the reproduction of a Graeco-Roman canon as a standard of worth.[31] Symptomatic of this was the work of sculptors like Rodin who in his workshop created a rough, fragmented sense of the sculpted form, one that was expressive rather than reproductive or classical. Such creative 'geniuses', forming works that were raw and singular expressions of emotion, were the new artistic ideal. However, as the example of Rodin shows, much of this art was collaborative and reproduction, whether in the form of a cast or otherwise, was essential to dissemination. Despite these realities, 'authenticity' became the new buzzword in the museological world and it came to stand in direct opposition to the replica or restoration. In the works of Walter Benjamin, the inauthentic copy stands as an assailant of the original. In his words, as the copy lacks historical testimony, its very existence jeopardises the authenticity and authority of the original, and the power of its story.[32] This is an opinion mirrored by John Ruskin when he states that an original, however worn, still contains 'some life, some mysterious suggestion of what it had been, and of what it had lost; some sweetness in the gentle lines which rain and sun had wrought', while a copy or conjectured reconstruction contains nothing but 'brute hardness'.[33]

Authenticity

The term 'authenticity' is one that lies at the heart of twentieth century museological management and display. It defines the relative value of an artefact or artwork as pertains to its ability to identify as belonging to a particular period or culture. Authenticity has become another way for museums and visitors to classify art and artefacts. However, since art and artefacts as categories are essentially produced within the museum, the concept of authenticity is equally variable depending on the place, time and motivational context within which something is categorised as such.

31 Wallach 1998, 38–9; Nichols 2006, 117–27; Siapkas and Sjögren 2014, 99. For an in depth analysis of this decline, particularly in Germany see Borbein 2000.
32 Benjamin 2010.
33 Ruskin 1900, 184–5.

In its most circumscribed parameters we can define the authentic object, in direct opposition to the inauthentic object, as a one-of-a-kind expression of an original thought or experience. In a more inclusive definition, the authentic object becomes anything used to express a particular message, whether emotional or informative. Rather than implying an absolute truth or falsehood, authenticity then functions as a performative word that attempts to achieve a specific effect, not as a descriptive one.

As art historian David Phillips posits, authenticity is not a stable concept but 'a shifting sand on which to base practice', one that is inevitably tied to the subjective reception of qualities like originality, creativity and legitimacy.[34] Too often these terms are approached as absolutes and conflated with legislative questions of authority and ownership. Laws like the early French Copyright Act of 1793 had already cemented many of these immaterial qualities by sanctifying the original work of an artistic genius. While this legislation was necessary to ensure

Figure 2: Legs in the garden of Musée Rodin, Paris.
Philippe Alès 2014, Creative Commons Attribution-Share Alike 4.0 International.

34 Phillips 1997, 1.

against forgeries and intellectual theft, the language used within it carried moral weight far beyond this legal context: *Par quelle fatalité faudrait-il que l'homme de génie … n'eût à se promettre qu'une gloire stérile, et ne pût revendiquer le tribut légitime d'un si noble travail*.[35] The use of words like *génie* (genius), *gloire* (glory) and *légitime* (legitimate) in this text are mirrored in later arguments made by artists, museum trustees and administrators when arguing against the use of 'miserable plaster imitations'.[36] They also show the cultural world within which such museums placed themselves at the time, being temples of artistic genius, rather than spaces for democratic learning. In this world, casting could only happen if it was part of the original and legitimate artistic process and even then the cast was seen as something that cheapened the original in some way.

The opus of Auguste Rodin is a case in point. Rodin is described as the father of modern sculpture but his training was in classical sculpture and he staunchly strove throughout his career to be accepted into the artistically conservative French Academy.[37] This implies a dichotomy between how Rodin perceived his own work, as connected to sculptural tradition, and how we now perceive it, as something thoroughly disconnected from his predecessors, something distinctly modern. Rodin's contemporaries must have also considered it irreconcilable with classical aesthetics, as the artist was not accepted into the École des Beaux Arts. Another concept that has been debated in relation to the works of Auguste Rodin is the 'genius' of the artist. As his work was not accepted within the canonical academy of French art in his early life, a myth of artistic isolation and individual genius grew around his character. After his death an article was published naming him 'a neglected genius' crucified by commerce.[38] However, Rodin's work was well-recognised before his death and he was featured in a number of Salons and even the Exposition Universelle held in Paris in 1900. Rodin's use of a complete workshop of sculptors, models and craftsmen, does not correspond to our modern

35 'By what ill luck, would a man of genius … have to make do with fruitless admiration, and not be able to claim honour worthy of such noble efforts' (Bently and Kretschmer 1793).
36 Wallach 1998, 53.
37 Le Normand-Romain 2014.
38 Borglum 1918, 151.

understanding of the artist as a singular genius. Rodin's works were after all collaborative efforts and not the product of a singular isolated prodigy. His workshop was also the source of many casts of his work, contesting notions of the absolute originality and the uniqueness of his sculptures as *objets d'art*.[39]

Depending on your viewpoint, Rodin's works can then be seen as classical or modern, the product of a genius or a group of craftsmen, original or copies, authentic or inauthentic. These terms, laden with values far beyond their own scopes, are the 'bread and butter' of museum and gallery discourse, these spaces aim to provide the visitor with an authentic experience, in which they get to see original pieces that illustrate man's genius. This self-assigned function suggests that the museum is a communicator, interacting with its visitors in order to facilitate this 'authentic experience'. Within this process, the artefacts and artworks become both the medium for and subject of these conversations. Can the replica then be given the same role? Duncan F. Cameron would suggest they could not. In his 1968 piece on museum communication systems, Cameron makes a clear distinction between the real thing, and those things that function as models, images or representations. While the real thing can communicate independently, the copy can only point towards that which it mimics.[40] However, replicas represent many things that an original cannot: the very act of replication communicates something about the value of the 'original' as well as museological practice. This broader view was represented by historian Klaus Schreiner in the 1980s in his definition of the authentic museum artefact as 'an individual expression of social or natural processes' that has emotional impact or adds to knowledge.[41] This definition opens up possibilities for copies as authentic expressions of the process of replication, as it does not include the subclause necessitating absolute singularity, as Cameron's does.

The transition between these two models, Cameron's opposition of real and imitative in the 1960s and Schreiner's more inclusive definition in the 1980s, may

39 Krauss 1985, 171–95.
40 Cameron 1968.
41 Schreiner 1985, 63.

indicate an opening up of museums towards more diverse display strategies. The turn of the millennium once again saw great changes in the nature of museology, this time in the field of community engagement. Already within Cameron's model there is a notion of communication, of collaboration between visitor and museum. By the late 1980s and early 1990s, these types of inquiries had developed into a complete reassessment of the role of museums within their own communities. Rather than focusing on a specific method, the museum was moving towards a practice based on outcomes, allowing for more variety in 'questions, techniques and approaches'.[42] This has not only allowed for a broader interpretation of the museum, but also what can be considered an authentic museum experience and the objects that can facilitate it.

More recently the importance of such open interpretations has become particularly significant with the growing awareness of heritage warfare, where attacks on material culture function as conflict strategies. Though there is still debate on the level of authenticity such replicas can provide,[43] in cases where access to the 'real thing' is no longer possible, museums have begun to take a broader approach to the exhibition object and its possibilities, including photographs, models and other simulacra. Museums now not only display replicative materials but also use replicative technologies to facilitate visitor participation in the museological process. By reconsidering their own categorisations the museum staff can then continue to address the importance of the authentic experience to museum visitors, while still remaining relevant and engaged with the world around them.

3D printing

One of the most recent introductions into this world of museum engagement is the 3D print. Museum prints function as tactile, interactive forms for connecting with artistic and archaeological materials. Much like the plaster cast, this form of replication creates a physical copy of the 'original', one that can be infinitely

42 Macdonald 2006, 1.
43 See for example the case of the 3D print of Palmyra's temple of Bel (Woodman 2016).

reproduced and modified. Both methods also include a second layer of replication within their creation process, and they have both been caught up in debates on authenticity and the museum object due to their material estrangement from their own 'originals'. 3D prints create a sense of displacement from their original context. Like plaster casts they are often separated not only in motivation, method and material from their originals, but also in space. However, while in the heyday of casting this replication was necessarily tactile, in 3D printing today a model can be made without ever handling the object being modelled. In contrast, for plaster casts, a negative mould was made of the original and then filled in with plaster, a 3D print requires laser scans or photos to be stitched together to create models that can then be used to build a replica. The temporal and technical disjunction between the two methods means that 3D printing is perhaps even more alienated from the classical and archaeological pieces that it mimics due to its computerised process. This being said, the 3D printer is more accurate and versatile than the casting process. The ability to create a print with no need for a permanent supporting structure allows it to be more flexible in its form. 3D prints are also increasingly particularised in their materials,[44] their density, weight, texture and appearance achieving products that are often closer to the 'original' in their effect.[45]

An additional benefit of 3D printing is that casting does not have is the ability for 'flip-flopping'.[46] The process of 3D printing implies a combination of two approaches: the physical and the digital. From the 'original' physical object, a digital mutable copy is made, which is then refashioned into a new physical

44 The most commonly used materials are the plastics Nylon, ABS, PLA. These can be produced in filament form or, for a more accurate but often more expensive product, Nylon can be used in powdered form and PLA in its resin form. Other materials include Laywood, gypsum, aluminium, cobalt, stainless steel, gold, silver, titanium, ceramic and paper. New materials are being developed by various companies in order to expand the applicability of 3D printing (3D printing training led by Vincent Khau at the University of Melbourne Engineering Lab 13 April 2016).

45 See for example 'The Next Rembrandt painting' 3D printed with paint-based UV ink on canvas (Brown 2016, 5 April).

46 Jakobsen 2016.

form. This digital mutability means that the intended reproduction can be easily adapted to a whole series of functions. This includes the integration of 3D printed images with other enhanced imaging techniques like Reflectance Transformation Imaging or Multispectral Imaging to reveal additional information. Not only can the digital 3D model be displayed within a virtual context, allowing for the narration of a more complex and integrated object history, but there are also a number of less evident benefits. 3D modelling can aid in museum display as stands can be built through negative imaging that exactly fit museum objects. It also opens up new pathways for research in terms of visual analysis and contextual reconstructions. Brittle or sensitive artefacts can be laser-scanned and printed, to be studied without any risk to the 'original'. 3D printing also has commercial benefits for museums in terms of merchandising: an Egyptian sculpture can be flattened into a magnet or shrunk to become a necklace ornament. The producer can even choose to freehand the 3D print design, creating a digital object that is connected to the physical world, but not directly modelled off it. A process that would have taken a great deal of material and human resources in the case of a clay model and cast, could now potentially be done with a few clicks of the mouse. This capacity for creative independence has allowed for a more flexible process of reproduction and has contributed to the popularity of 3D printing in a wide pool of applications beyond museums, within industry prototyping, medicine, bio-chemical engineering, architecture and even fashion design.

Among these applications, museums were late to really embrace the 3D print. The financial and technological investment required for early 3D printers and their software prohibited museums from accessing the technology until the 2010s, even though 3D printers have been around since the 1980s.[47] There were also more ideological hindrances to the adoption of the new technique. The late twentieth century struggle for the soul of the museum was based around a change in the definition of the museum from a space for strictly curated display to a place of engagement and change. However, in its early years this 'new

47 Lipson and Kurman 2013, 36, 68, 75.

museology' was much more involved in rewriting the theories and conceptual assumptions surrounding museums. Museum objects had to become understood as 'situated and contextual', having the capacity to shift along with the value systems held within society.[48] Only once this conceptual framework had been rebuilt could methods be developed to achieve the institutions' new functions. The implementation of these methods was equally fraught with difficulty, many museums going through a process of trial and error, with criticism oscillating between the extremes of didacticism and 'Disneyfication'. Thus, 3D printing has emerged and flourished within a period of increased experimentation, and an openness to more interdisciplinary, popular and mechanised approaches to the museum collections.

Another aspect that has contributed to the museum sector's inhibitions regarding 3D modelling and 3D printing is that of the legal and ethical ramifications of replication. Even before the 3D print there was already an ongoing debate about the ethics of using plaster casts in lieu of 'authentic' objects in museums. A key point here was the museum's integrity and retaining the confidence of the visitor without sacrificing the visitor experience.[49] It was a debate about how museum staff should display and label replicas as 'copies'.[50] However, 3D modelling and printing provides an extra level of difficulty, as they can be easily created outside the sanctioning of the museum. In a world where 'copyright, design rights, moral rights, trademarks and patents are all intellectual property rights', replication of cultural and aesthetic artefacts can be a minefield.[51] Original artistic works are protected from replication, virtual or physical, under copyright law for 70 years after their creator's death, but it is hazy how this might apply to scanning an existing copy of an artistic work. There are exceptions for works on public display, but again the definition of public space is an issue here. The vagueness

48 Macdonald 2006, 2.
49 Ruskin 1900, 185–6.
50 This topic was discussed at length at the annual meeting held by the ICOM International Committee for Museums and Collections of Archaeology and History (ICMAH) in 2010 (ICMAH 2014).
51 JISC 2014, 17 January.

of how these rules apply is most clearly illustrated in the case of a cast of Michelangelo's Moses on the campus of Augustana College in Sioux Falls that was scanned for 3D printing as public art by Jerry Fischer.[52] Fisher was acting under the assumption that the piece was a cast made off the work of a man long dead that was being exhibited in a public space. However, he was soon contacted by the college who considered his act a copyright infringement as he had not asked permission to create the scan. Though legally he was in the right, there is still a question of ownership that can be presented here for the college and the sculpture's donors. Museums, while being public institutions, do have certain rights as custodians of the materials within their galleries. This implies specific restrictions on photography and replication that are legally enforceable. While these restrictions can be hard to enforce on photography, until now it was easy to do for full physical replication as casts are laborious manual feats. 3D printing removes the need for physical contact and museums have had to create strategies for dealing with this new demand. The British Museum and Smithsonian are two

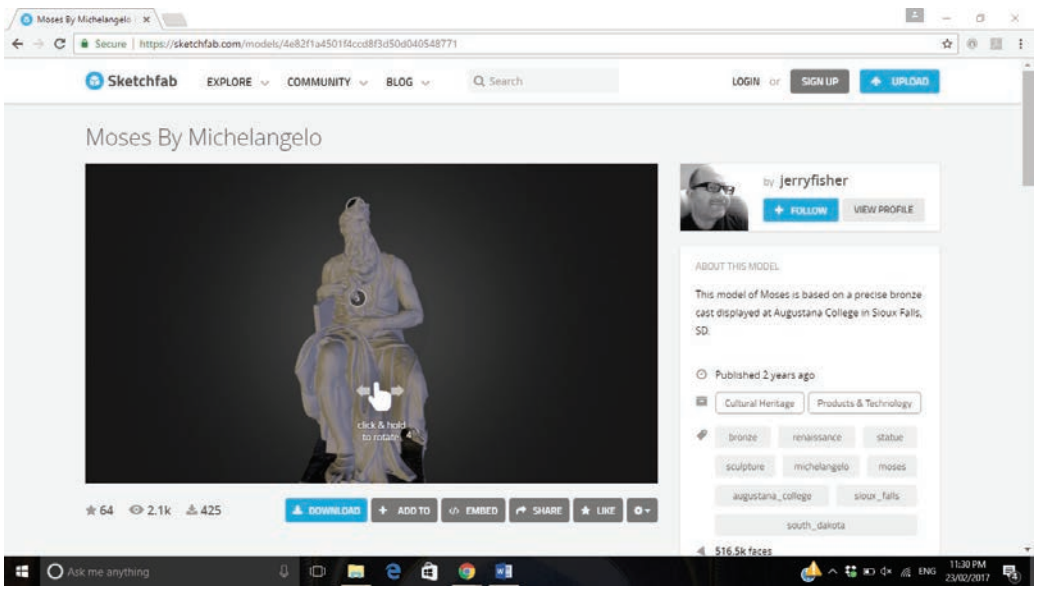

Figure 3: 3D model of the Augustina College Moses statue made by Jerry Fisher. Public Domain.

52 Cascone 2015, 28 January.

museums that have really embraced the 3D printing craze and made their own scans available to the public, while the MET has even organised 3D Hackathons allowing visitors to create their own scans.

The method of 3D printing has become so popular that it no longer just serves as an aide to understanding a museum collection when the 'original' is unavailable or unsuitable. It also has become the production method for objects that are exhibited in their own right. In the spring/summer of 2016 a number of major exhibitions were held focusing on the potential of 3D prints. At the University of Queensland (UQ), the Anthropology Museum hosted the exhibition *The Real to Relic: Museums in 3D*. The exhibit, a demonstration of 3D technologies used within UQ particularly for their fossil collection, was developed as a way of exploring 'the possibilities of 3D modelling and printing for both museum workers and visitors'.[53] In a similar spirit, but with a more industrial focus, exhibitions were mounted in New York (*Manus x Machina—Fashion in an Age of Technology*), Paris (*3D Printing—Factory of the Future*) and Milan (*Immediate Future—3D Printing*) to showcase the various applications that 3D prints have within our current and future culture. Perhaps the most extreme version of this is present in the United Arab Emirates' recently unveiled plans to build a museum of the future, in part using 3D printing technology.[54] 3D printing here is not just deployed as a display and research strategy, but becomes part of the fabric of the museum itself.

Learning with casts and replicas

The basis of museum learning is the tenet that engaging with objects—such as specimens, artefacts, books, photos, artworks—somehow enhances the visitor's understanding or appreciation of the subject being presented. The object here is both the focus and facilitator of learning. However, in most museums the object stands as something outside the direct engagement of the visitor. It sits within a

53 Hinds 2016.
54 MOTF 2016.

case or hangs in a frame. This limits the visitor's experience to a one-dimensional view of the object, a single object narrative. Text panels can help sketch the object's biography in greater detail but these often provide merely a shallow interaction with the viewer. Multi-sensory alternative encounters provide far more memorable experiences that aide in the learning process, and allow visitors to create connections between their own lives and the exhibit. They also have the potential to open up exhibitions to a wider range of people by engaging them through other senses like touch and sound, thereby not requiring the ability to read or even see to enjoy the exhibition. One extensively tested, productive way of doing this is through tactile object-based learning (OBL).

OBL involves the 'integration of the object into the learning environment'.[55] This means that rather than experiencing an object at a distance, the learner is in direct contact with the object allowing for deeper multi-sensory and dynamic engagement. This can be applied on site at the museum in workshops or OBL stations, or it can be taken to universities and classrooms where learning would normally be done through images and descriptions of the material being studied. These encounters create an environment between institutional and informal learning, giving students more autonomy over their own study by putting the objects in their hands. Research has proven that these intimate object-centred experiences help develop not only subject specific knowledge and subsequent research, but also a number of transferable skills including: communication, practical observation, data collection, data analysis and teamwork.[56] OBL is an example of experiential learning, as described by Kolb in 1984, it involves an integrated cycle of having an experience, reflecting upon it, conceptualising or theorising it and then relating it to your own life through creating your own ideas for how to instigate a similar or different experience that builds on your previous encounter.[57]

55 Chatterjee and Hannan 2015, 1.

56 For an in depth view on the development, practices and benefits of object based learning in museums and tertiary educations see Paris 2002 and Chatterjee and Hannan 2015 respectively.

57 Chatterjee and Hannan 2015, 20.

However, OBL requires a collection to be made available for tactile engagement by learners. Some museums and universities are lucky enough to have stores of objects that can serve as a handling collection and others have access to materials for teaching through bequests. But this is not always possible. There are many institutions where these resources are lacking and some collections are just too sensitive for tactile engagement. Some museums and regions lose their resources due to war and conflict.[58] In these cases a replica or tactile substitute can serve as a great way to implement OBL without requiring extensive access to the 'original' objects.[59] Replicas of key pieces can be bought or constructed to allow students at any institution access to them. Replicas can even serve to mitigate some of the difficulties students experience when they are unable to be physically present in classes. The University of Southern Queensland for example integrates 3D printing into their distance learning program for archaeology, sending prints of key objects to the homes of remote students so they can examine them while following the lectures and tutorials online.[60]

Replicas can be manipulated to serve specific needs. In the case of archaeological drawing classes, students can access a ready-made, cut-away view to better understand the construction of the vessels and the different viewpoints required for representing them clearly. They can also be reconstructed to give a better impression of the life of the object post excavation. For example a set of two Parthenon marble replicas could be created with one painted and complete to indicate their original appearance, and another brushed white or eroded to show their appearance after entry into museums or after weathering.

Casts in particular have an ability to showcase something of the past. They embody a period in the history of archaeology when copying artworks and antiquities was considered essential to appreciating and studying them. They often represent ties between people, institutions and governments that are indicative of the formation

58 Neumüller et al. 2014.
59 Di Giuseppantonio Di Franco et al. 2015, 243.
60 Scott 2016, 29 July.

Figure 4: Professor Bryce Barker showing the original and replica skull used to teach archaeology at the University of Southern Queensland.
Reproduced with permission of the University of Southern Queensland.

of not only art and archaeology, but wider issues of diplomacy and commerce. They also indicate a specific method; a physical practice that was an essential part of artistic training until relatively recently. It is therefore important to analyse casts and replicas within the framework of their own 'socially constructed meanings' rather than through traditional discourses of the authenticity of the original as opposed to the replica.[61]

Much like plaster casts, 3D prints empower students and visitors to engage with the past in material ways. 3D printing carries additional benefits through its connection to a digital format, allowing for flip-flopping, and the wider availability of its production methods. Beyond engagement with the past, 3D printing puts the tools in the visitor's hands creating a maker culture, and thereby transforms museums into a maker space. It takes OBL to a whole new level, one that involves a more concrete sense of creation and participation as the visitor can

61 Foster and Curtis 2016, 142.

bring the museum home through using 3D prints from repositories like the British Museum's Sketchfab collection or Smithsonian X 3D. There they can not only view the collection, but they can manipulate it and build upon it. This approach embraces guided, independent and group experimentation, trial as well as error. Learners are encouraged to share their creations and experiences. 3D printing also allows experimentation within the digital sphere, not every creation needs to be reformed physically. While technology is not something that archaeological and art museums have been quick to embrace there is great potential for innovation. At the National Museum Cardiff for example, a competition entitled *(Im)material Artefacts* was held to create new works based on 3D scans of pieces within the collection.[62] This was not only an innovative project, but it drew on community resources and creative potential to enhance its collection. It is but one of many stories of how 3D replication generates 'excitement and engagement, encouraging curiosity, attention, and desire for knowledge about past material culture'.[63]

Conclusion

Far from being mere copies of originals, replicas like plaster casts and 3D prints empower visitors and learners to set their own parameters of engagement and build their own knowledge, whether this be through kinetic engagement or the manipulation of a 3D model. These actions express the potential for such replicas to become original in their own right, affecting the learner through their kinetic engagement with the material. These types of object-based and creative learning are often more memorable, and thus more conducive to learning than traditional learning through textbooks, images, or even museum tours.

However, there are still some unresolved drawbacks to using replicas over 'originals', the primary one being their diminished affectivity when revealed as copies. Replicas do not hold the same life story and subsequent emotional weight as their model objects. No matter how accurate the copy, students and visitors will

62 Younan and Eid 2016.
63 Di Giuseppantonio Di Franco et al. 2015, 260.

still attribute a different value to holding an authentic object, and thus touching the past. In addition to this not all replicas are created equal. Though methods of reproduction are becoming increasingly accessible over time, manufacturing a good replica is still a time-consuming and expensive process requiring a significant amount of resources.

The significant resource investment required for such a project makes careful planning vital. It is necessary to draw a clear line between the aim of the project, and the proposed methods for achieving that aim. There are particular strengths and weaknesses connected to plaster casts that differ from those of 3D printing and these need to be assessed. As each medium forces the learner to look at the material differently, they bring up different parts of the object's biography. This should translate into museum and classroom practice, where facilitators should plan interactions with replicas in accordance with their material, method of production and history, rather than applying a blanket approach to all forms of replication. Certain subjects may also benefit from different types of replicas: newer is not always better. More traditional methods like plaster casting have the advantage of carrying with them the history of museology and academia, while 3D printing corresponds better with the modern maker-culture.

Both plaster casts and 3D printing can be used to enrich the learning experience within the fields of art and archaeology. They provide a way to connect with material culture that allows for a great deal more flexibility, manipulation and creativity. This is ultimately the role replicas in museums should play, not replacing artefacts but rather enhancing their stories, adding to the museum's potential and cementing its significance within its community.

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