

Like Jacob with Esau: The 3D Printed Replica and the Future of the Museum

James Andrew Walton

Thesis submitted to the faculty of the Virginia Polytechnic Institute and State University in
partial fulfillment of the requirements for the degree of

Master of Arts
In
Material Culture and Public Humanities

Aaron Ansell, Committee Chair

Brian Britt

Rachel M. Scott

May 5th, 2018
Blacksburg, Virginia

Keywords: Museums, 3D Printing, Replicas, Aura, Hyperreal, Despatialization, Auratic,
Exhibits, Multisensory Exhibitions

Copyright 2018, James Andrew Walton

Like Jacob with Esau: The 3D Printed Replica and the Future of the Museum

James Andrew Walton

ABSTRACT

The importance of the aura, the metaphysical element that gives art, artifacts, and other objects of cultural heritage their authenticity, has been heavily contemplated ever since the publication of Walter Benjamin's "The Work of Art in the Age of Mechanical Reproduction." This thesis strives to add to this conversation and expand upon it by delving into the emergence of additive manufacturing, or what is more commonly known as 3D printing, and its relation to museums and other institutions that comprise the public humanities. This technology challenges the auratic properties of an exhibit by first digitizing it onto a computer by scanning it and then uploading this data to a 3D printer, which then proceeds to replicate the scanned exhibit down to incredibly fine details. For museums the possibility that 3D printed replicas, increasingly able to be indistinguishable from the original and capable of being produced in great numbers at ease, replacing their auratic exhibits is a very real possibility to consider. This thesis argues that some museums are responding by despatializing their exhibitions in order to uphold their auratic exhibits, while others are offsetting the potential loss by turning their exhibitions into tactile, multisensory experiences. Either option, which are not mutually exclusive, transforms the traditional museum. This thesis ultimately concludes that it's possible to reconcile the auratic exhibit with the 3D printed replica should these institutions properly adapt. Doing so will allow them to continue fulfilling their mission statements to preserve and promote the auratic exhibits well into the future.

Like Jacob with Esau: The 3D Printed Replica and the Future of the Museum

James Andrew Walton

GENERAL AUDIENCE ABSTRACT

The emergence of 3D printing in recent years has brought with it many implications for not just society, but also the museums and other institutions that comprise the public humanities. Along with printing out objects designed entirely within a computer, 3D imaging and printing technology can easily process scanned objects that have been digitized onto a computer and then reproduce that object while accurately mimicking the specific features that once made it unique. As they increasingly improve in their ability to print with more and more materials, distinguishing the original from its copies from sight alone brings with it an existential dilemma for museums that rely on the authenticity of the original to draw visitors. If everyone could potentially have their own life-size copy of *David* thanks to a 3D printer, what fate awaits the original *David*? This thesis will detail this possible development and how exhibitions are responding. Arguing that some museums are in fact utilizing 3D printers outside the halls of their institutions in order to uphold their original collections, while others are offsetting the potential loss by embracing the reproducibility 3D printers provide to allow visitors to touch and interact with 3D printed copies in multisensory exhibitions. Either option, which are not mutually exclusive, transforms the traditional museum going experience. This thesis ultimately concludes that it's possible to reconcile the original with a perfectly mimicked copy should these institutions properly adapt, allowing them to fulfill their missions to preserve and promote the originals well into the future.

Table of Contents

Introduction –	1
The 3D Printed Arch of Triumph: A Brief Case Study –	4
Defining the Original from the Copy –	8
Despatializing Auratic Exhibitions with 3D Printing –	12
Innovating Auratic Exhibitions with 3D Printing –	20
Conclusion –	28
Bibliography –	30

Introduction

On May 21, 2015 in the midst of the Syrian Civil War, the Islamic State captured the UNESCO World Heritage site of Palmyra, Syria. The Islamic State deliberately targeted the ancient Roman monuments and relics that had been preserved there since antiquity in an act of defiant iconoclasm. What separates this particular incident of cultural destruction from countless others in human history was not the tragedy of the loss in and of itself, but rather the response from the institutions that had been monitoring the occupation of Palmyra. UNESCO, in partnership with the Institute of Digital Archaeology,¹ had worked together some months before Palmyra's capture to utilize 3D cameras to digitize the Arch of Triumph into a 3D virtual model. Using the same kind of Egyptian marble that the Romans had carved the original monument out of, the IDA used 3D printing technology to entirely recreate the Arch of Triumph down to its tiniest details scanned. Though it is only two thirds of the scale of the original, its official reveal in London brought with it a myriad of questions concerning the implications that the concept of a 3D printed replica represented. For instance, in reviving the legacy of a work of cultural heritage that has been utterly destroyed, could such a replica supplant the original in the public consciousness? Moreover, if a computer can so thoroughly replicate an object of cultural heritage, than what implications does this act of material resurrection represent to the institutions of the public humanities?

The term, "3D printing", has been increasingly entering the mainstream cultural zeitgeist through the 2010's. It is officially called "additive manufacturing", a phrase that denotes a synthetic process by which a digital object – existing within a computer – is created in physical reality with a level of precision that only a machine could accomplish by additively building the

¹ Which itself was a joint venture between Oxford University, Harvard University, and Dubai's Museum of the Future.

object layer by layer onto itself rather than assembling it through a traditional manufacturing process. This technology allows minute details to be added to the object that otherwise could not be matched at the same speed competency by human hands. 3D printing was first conceived in the late 1980's as a stereolithographic process for rapid prototyping scale models of objects during a product's design phase.² However, the potential of these 3D printers grew with their increasing capabilities in tandem with their reduction in size – allowing their marketability to be expanded to the general public with the introduction of home desktop 3D printers. All of this in combination with high definition 3D scanning and imaging has opened the way for objects (works of art, artifacts, and even structures) to be digitized into a virtual space and then physically recreated into a three-dimensional object by a computer operated 3D printer. This recreation, a copy of an original, is otherwise known as a replica. Museums have long used replicas in the place of an original object, but what separates 3D printing from past instances of replicas is their ease of sheer reproducibility combined with their both their relative affordability and aforementioned level of detail that exceeds human speed and skill. This opens up new avenues of thinking and consideration of just what a replica can be in the museum going forward. Rephrased as a question: What can museums accomplish with their exhibitions utilizing replicas that so perfectly mimic the appearance and texture of their original exhibits while simultaneously being so easily replaceable?

Thus, this thesis is mainly concerned with the 3D printer's potential to replicate an object to such a degree as to challenge a clear distinction between the original and the copy. The thesis will argue that museums are responding to this possibility brought forward by 3D printing in two ways: by using 3D printing to despatilize their exhibitions outside the halls of their institutions or

² Joseph Flynt, "A Detailed History of 3D Printing," *3D Insider*, <http://3dinsider.com/3d-printing-history/>

instead by using 3D printing to augment their exhibitions and fundamentally change the exhibition experience away from a glass-case paradigm meant to protect the fragile, priceless original and instead towards a tactile, multisensory experience. Since these options are not mutually exclusive, the museums then are using 3D printed replicas to both supplant and supplement the original work and completely transform the museum experience. This relationship is similar to that of Jacob with his older twin Esau in *Genesis*. Jacob initially supplanted Esau's birthright before the twins eventually reconciled their antagonism. So too does this thesis foresee the eventual relationship between the original and the 3D printed copy. The copy may fully replace the original for purposes of exhibition, yet the sheer reproducibility of the 3D printed replica also allows the original to be further preserved and protected from the exposure that comes with being exhibited. This simultaneously ensures that the original can be safely stored for future study for many years to come. Thus while the emergence of 3D printing may seemingly threaten the future of the museum, it in fact does the opposite – reaffirming the typical museum's mission to preserve and promote the past to the public.

This argument will be undertaken in a threefold manner divided into four sections. The first section titled "The 3D Printed Arch of Triumph: A Brief Case Study" will further examine reactions from authors like Stuart Burch and Elrich Hatala Matthes to the Arch of Triumph replica, highlighting the problematic dichotomy that stands out in how the 3D printed recreation was underutilized in relation to what 3D printing technologies can achieve. The second section titled "Defining the Original from the Copy" will act as a literature review of the works of Walter Benjamin, David Harvey, and Annette Weiner to theoretically explore what precisely separates the perfect 3D printed replica from what makes the original so special and sublime, defining it as the "auratic exhibit". The third section titled "Despatializing Auratic Exhibitions

with 3D Printing” will then covers how museums are emphasizing the appeal of their auratic exhibits through the emergence of 3D printing by engaging examples provided by authors like Charles Cronin, Fiona Cameron, Bernard K. Means, Sarah Younan, and Moritz Neumüller. Finally, the fourth section titled “Innovating Auratic Exhibitions with 3D Printing” showcases the examples provided by authors like Paul F. Wilson, Théophane Nicolas, Megan Hancock, and Hannah Turner among others on how 3D printed replicas have changed auratic exhibitions to be more accessible, multisensory, and tactile experiences. This is then followed by a brief conclusion that reviews the revolutionary nature of the 3D printed replica and ponders the future of the museum undergoing this transformation.

The 3D Printed Arch of Triumph: A Brief Case Study



Figure 1, The original Arch of Triumph located in Palmyra, Syria before its destruction.³

³ Bridget Butler O'Neal, “Palmyra’s Arch of Triumph Replica Unveiled in Trafalgar Square—Next, On to Dubai & New York,” *3DPrint*, April 20, 2016, <https://3dprint.com/130628/palmyra-arch-traffic/>



Figure 2, The Institute of Digital Archaeology's 3D printed replica of the Arch of Triumph.⁴

The Arch of Triumph replica stands out from other works of 3D printing by the nature of its creation. While both industrial and desktop 3D printers currently utilize plastics and various kinds of other moldable materials, the Arch of Triumph replica was in a literal sense carved in an open-air exterior environment.⁵ The macro-sized extruder, acting on the same data printable in its conventionally sized cousins, cut a block of Egyptian marble into the exact same shape of the digitized Arch of Triumph as captured by 3D imaging techniques. The IDA hopes its experiment will pave the way for similar 3D printing techniques to be implemented in the restoration of smaller artifacts destroyed at Palmyra and elsewhere in the world.⁶ Since it was unveiled at Trafalgar Square, the replica has toured around the world. Going to Oxford, New York City, Dubai, Florence, Italy, before finishing at Arona, Italy⁷. The fate of the replica is somewhat problematized by the ongoing Syrian Civil War. While initially intended to be a permanent

⁴ Ibid.

⁵ Erik Simmons, "Triumphal Arch of Palmyra Under Construction," *Vimeo*, <https://vimeo.com/161046225>

⁶ "Palmyra's Arch of Triumph printed in 3D," *CNN*, <https://youtu.be/SKCpnEqF4bE?t=1m25s>

⁷ "Triumphal Arch," *The Institute of Digital Archaeology*, <http://digitalarchaeology.org.uk/media/>

memorial to Palmyra's caretaker Khalid al-Asaad, who was executed by the Islamic State in the aftermath of site's capture, the Arch of Triumph replica may yet find itself exhibited at Dubai's Museum of the Future that is still undergoing construction at the time of this thesis' writing.

While there was a strongly positive media coverage of the Arch of Triumph replica, the exhibit had its fair share of criticisms as well. Stuart Burch in bluntly comparing the replica to those of recreated monuments found in Las Vegas states, "Its fleeting presence in Trafalgar Square was intended to generate a debate about the potential of reproductive techniques. It undoubtedly succeeded in this objective, revealing in the process that the nature and purpose of digital technologies in the field of heritage conservation are deeply contested and fraught with challenges."⁸ Meanwhile Elrich Hatala Matthes lauds the effort by the IDA and the vast potential that reconstruction through 3D printing can bring to cultural heritage. He argues that these institutions exist primarily to maintain artifacts of cultural heritage in order to help the public reconnect, reexamine, and reevaluate their past. As Matthes elaborates, "Unfortunately, many of the Palmyra reconstructions have not met these criteria. The IDA failed to give context to its 3D-printed Arch of Triumph. It lacked adequate programming or signage, and didn't explicitly connect with the violence that led to it. Together with Syrian archaeologists, the project could have been used to educate the West about colonialism in Syria and its continuing legacy, but instead it was mere spectacle."⁹ Matthes' response suggests that a replica – no matter how well it mimics the original – nonetheless faces an uphill struggle towards legitimatization. Yet museums do not exist solely to house "original" works, whether they be artistic creations or artifacts of

⁸ Stuart Burch, "A Virtual Oasis: Trafalgar Square's Arch of Triumph," *ArchNet-IJAR : International Journal of Architectural Research*, 11, no. 3, (2017), 67.

⁹ Elrich Hatala Matthes, "Palmyra's ruins can rebuild our relationship with history," *Aeon*, March 8, 2017. <https://aeon.co/ideas/palmyras-ruins-can-rebuild-our-relationship-with-history>

cultural heritage; they have long utilized replicas (of varying degrees of quality) in lieu of the original in order to fulfill their missions of educating the public.

The case study of the IDA's Arch of Triumph replica reveals an interesting dichotomy between the traditional notion of an exhibit and the special interests promoting said exhibit. The crux of this conflict lies in the fact the data to recreate the Arch of Triumph theoretically exists anywhere in a globalized world with access to 3D printing technologies. Put in a more practical statement: A single replica was toured across several countries even as the greater, underlining implication of the replica's existence proclaimed something much different, that a multitude of copies could theoretically be just as easily be fabricated by 3D printing and evenly distributed across these same locales all at once. This was in fact the initial goal of the IDA, which had planned to unveil two Arch of Triumph replicas at the same time in both London and New York City.¹⁰

The instance at play here is that the means of this computer driven replication process, 3D printing, represents a seemingly antithetical solution to the goal of safeguarding works of cultural heritage. Instead of reinforcing the majesty of the original work, the sheer reproducibility that a 3D replicated copy offers threatens to undermine what makes the original so valued as an exhibit – that it is spatially bound to a specific place within the mind's eye of the viewer appreciating the exhibit. What differentiates 3D printing, from other forms of mass reproduction technologies like photography and film, is that those mediums can only principally convey an impression of their subjects through visuals. A 3D printed replica however goes a step further, allowing someone to tactilely engage the same subject in person; even when the original is deemed untouchable or off limits due to its fragility. It is within this scenario that a 3D printed

¹⁰ Burch, "A Virtual Oasis," 67.

replica has the potential to surpass the original precisely because it exists within a contradictory framework where it both devalued over the original while simultaneously transcending the original's physical limitations. This is particularly important to consider as 3D printing technologies increasingly advance in their ability to perfectly mimic an original object that has been digitized by a computer. In this digital age, it is hypothetically acceptable for a 3D printed replica to degrade and even be damaged – even if it looks and feels indistinguishable from the original – since the data and means to create another replica is possible through 3D printing. Yet the original work too, has long been recognized in its ability to easily stand out from the replica. Putting aside a common sense comparison of the craftsmanship behind the original, there are metaphysical elements at play that are worth addressing in their own right.

Defining the Original from the Copy

In addressing the theoretical nature of the replica it is fitting to start with Walter Benjamin. In his seminal essay regarding the work of art, Benjamin first points to the near universality of the replica in human history before exploring what fundamentally makes a replica so delegitimized: its lack of authenticity.¹¹ In Benjamin's own words,

The presence of the original is the prerequisite to the concept of authenticity. . . In the case of the art object, a most sensitive nucleus—namely, its authenticity—is interfered with whereas no natural object is vulnerable on that score. The authenticity of a thing is the essence of all that is transmissible from its beginning, ranging from its substantive duration to its testimony to the history which it has experienced. Since the historical testimony rests on the authenticity, the former, too, is jeopardized by reproduction when substantive duration ceases to matter. And what is really jeopardized when the historical testimony is affected is the authority of the object.¹²

Benjamin argues that this sense of authority imbued into the original object is what produces the sense of authenticity, which survives through the passage of time. Thus, when a work of art is

¹¹ Walter Benjamin, "The Work of Art in the Age of Mechanical Reproduction," in *Illuminations* edited by Hannah Arendt, translated by Harry Zohn, (New York: Schocken Books, 1969) 1935, 2.

¹² *Ibid.*, 3.

reproduced or replicated, the copies are stripped of this essence and thus are viewed as inauthentic to the original.

Benjamin then delves into what makes authenticity what it is. Giving the example of a statue of Venus as appreciated in two differing time periods, the first by the Greeks who venerated the statue and the other the clerics of the Middle Ages who viewed the statue as vice. Despite their contrasting perceptions of the statue, each embedded the object in a field of meaningful practices, which emanates back out of the object as its awe-inspiring “aura”. As Benjamin explains,

Originally the contextual integration of art in tradition found its expression in the cult. We know that the earliest art works originated in the service of a ritual—first the magical, then the religious kind. It is significant that the existence of the work of art with reference to its aura is never entirely separated from its ritual function. In other words, the unique value of the “authentic” work of art has its basis in ritual, the location of its original use value. This ritualistic basis, however remote, is still recognizable as secularized ritual even in the most profane forms of the cult of beauty.¹³

As technological development progressed, Benjamin argues that the ritualism that once solely basked and dictated the cultural significance of the work of art found itself competing with new, vastly more efficient forms of reproducible art; namely photography and film. Benjamin then makes a bold assertion,

An analysis of art in the age of mechanical reproduction must do justice to these [ritual] relationships, for they lead us to an all-important insight: for the first time in world history, mechanical reproduction emancipates the work of art from its parasitical dependence on ritual. To an ever greater degree the work of art reproduced becomes the work of art designed for reproducibility. From a photographic negative, for example, one can make any number of prints; to ask for the “authentic” print makes no sense. But the instant the criterion of authenticity ceases to be applicable to artistic production, the total function of art is reversed. Instead of being based on ritual, it begins to be based on another practice—politics.¹⁴

¹³ Ibid., 5.

¹⁴ Ibid.

With this Benjamin argues that the work of art no longer exists for its own sake but rather it lives to advance the interests of the institutions and societies that possess them. The work of art reproduced is rendered into culture, economics, and power - not just sacred ritualism – and as such can be utilized as a political tool to engage the masses.

David Harvey in his analysis of Benjamin’s essay some decades later focuses on the “cultural mass”, defined as the producers and consumers of cultural artifacts that act to transmit the culture to others, which is at the heart of the postindustrial global economy that emerged out of the Second World War.¹⁵ Accordingly, neoliberalism, as defined by Harvey, is the socio-economical ideology that believes human well-being can best be secured by liberating businesses while guaranteeing property rights, free trade, and free markets by way of curbing the government’s role in regulating these aspects of the economy.¹⁶ This in part has opened up avenues of electronic communication that act to reinforce and perpetuate this system of neoliberalism. Harvey argues that the cultural mass functioning in the center of this order gives individuals their social identity and thus both are defined by the declining belief in the authentic as well the emerging belief in the reproducible. As Harvey explains,

The politics of the cultural mass are, however, important since they are in the business of defining the symbolic order through the production of images for everyone. The more it turns upon itself, or the more it sides with this or that dominant class in society, the more the prevailing sense of the symbolic and moral order tends to shift.¹⁷

In this sense, the institutions that make up the public humanities (e.g. the museum) operate as some of the last bastions of original cultural objects and the ritualism of art that ultimately define authenticity.

¹⁵David Harvey, *The Condition of Postmodernity: An Enquiry into the Origins of Cultural Change*, (Massachusetts: Blackwell Publishing, 1990), 347.

¹⁶ David Harvey, *A Brief History of Neoliberalism*, (New York: Oxford University Press, 2005), 2.

¹⁷ Harvey, *The Condition of Postmodernity*, 348.

As an institution, the museum also plays a role in the reverence of authenticity. Within the public humanities, the museum must occupy a position where it must protect the preciousness of their collections while simultaneously sharing their importance (i.e. the reason they are deemed precious in the first place) with the public at large. This dualism is further explored by Annette Weiner who in critiquing the norm of reciprocity, an anthropological theory that imposes western notions of economy as a universal, contributes the concept of the “inalienable possession”. This is an object of precious quality. One that puts its owner in a seemingly paradoxical situation: where its owner wishes to both protect the continued existence of a possession as well as share the same possession with others in order to validate its continued existence. Weiner elaborating on her word choice says, “What makes a possession inalienable is its exclusive and cumulative identity with a particular series of owners through time. Its history is authenticated by fictive or true genealogies, origin myths, sacred ancestors, and gods. In this way, inalienable possessions are transcendent treasures to be guarded against all the exigencies that might force their loss.”¹⁸ If only by another name Weiner is precisely describing the powers of the aura that people mentally instill into an original object.

In respecting the exhibition-based format and structure of public humanities institutions such as museums, a vernacular term worth considering for the purposes of this thesis is that of the “auratic exhibit”. Which delineates both ritualistic inalienable aura and while also encompassing both the work of art as well as the artifact of cultural heritage within the boundaries of the public humanities. The auratic exhibit then, when considered in relation to the emergence of 3D printing represents the public humanities’ existential moment in the twenty-first century. Faced with the emergence and dissemination of 3D printed replication, public

¹⁸Annette B. Weiner, "Inalienable Possessions: The Forgotten Dimension," In *Inalienable Possessions: The Paradox of Keeping-While Giving*, by Weiner, Annette. (Oakland: *University of California Press*, 1992).

humanities institutions must both acknowledge and address what the future holds for their auratic exhibits. There are principally two adaptive choices: utilizing 3D printing to despatialize their auratic exhibitions or by innovating the traditional glass-case paradigm exhibition towards multisensory, tactile exhibitions that fully incorporates the 3D printed replica into the experience. These are not mutually exclusive options, but both represent a fundamental transformation to the traditional notion of the museum. A great deal of this is relies on the 3D printed replica itself. Which currently exists within two contradictory contexts. The 3D printed replica ultimately seeks to perfectly mimic an auratic exhibit, so as to supplant its sense of authenticity. Yet the 3D printed replica also attempts to break free from the metaphysical boundaries that bounds its predecessor to a singular, contained form – and move to where the 3D printed replica’s value is fully legitimized in its multisensory, multipurpose usage that comes from the lack of restrictions offered by its computer driven reproducibility.

Despatializing Auratic Exhibitions with 3D Printing

Reflecting on the auratic exhibits already within the possession of a public humanities institution, there is a great deal to consider when addressing 3D printing. If a museum’s objective is to prevent the loss of appeal of the auratic exhibit, than a good countermeasure involves carefully utilizing the potential of 3D printing outside the direct domain of the institution. In other words, the museum uses 3D printing as outreach in such a way that encourages the public to visit their museum. Thus, the need to deploy 3D printed replicas within a context that ultimately reinforces the validity of their auratic exhibits. In this regard, Charles Cronin, a legal scholar of USC Gould School of Law, makes an argument very much in favor of the notion that the emergence of 3D printing encourages institutions to maintain and uphold their auratic exhibits. He firstly points out that an artifact’s physicality is the heart of the problem when it

comes to its value in the modern world. Accordingly, the object's physicality makes it vulnerable, especially to intentional destruction by terrorists groups or warfare that could target a cultural object solely because of its historical and/or cultural value to those that revere it. Cronin even goes as far as to dismiss the moral rationale behind the act of repatriation, the act of transferring an auratic exhibit away from a museum and back into the hands of the government in control of its place of origin. As Cronin declares,

Even when antiquities are sent to the geographical locations where they were created, the inevitable political changes and human migrations over millennia render sophisticated claims of emotional attachment between the current population and that of the creators of the object. The fluidity of national boundaries further belies the legitimacy of repatriation claims rooted in jingoistic rhetoric.¹⁹

There is of course a governing treaty regarding the issue of repatriation, the UNESCO Convention Treaty of 1970, and while that mostly helps cement the matter in future cases; it does not apply retroactively – meaning that mainly former colonial powers are free to decline repatriating former colonies.²⁰

Cronin formally begins his argument that cultural heritage is best viewed as pure information; rather than within the context of its aesthetic qualities – be that economic, cultural, or material that empowers its traditional valuation from this basis.

A marble carving from Antiquity, for instance, is exponentially more valuable, economically and aesthetically, than a chunk of marble of equal age used as a curbstone in Athens today. However, a jeweled necklace from Antiquity might not sell for vastly more than a contemporary setting of the same quality gems and metals.²¹

Cronin goes on to say that the creators of auratic exhibits more often than not embedded them with valuable materials to increase their value and so when the object is stripped of its cultural

¹⁹ Charles Cronin, "3D Printing: Cultural Property as Intellectual Property," *The Columbia Journal of Law & the Arts* 39, no. 1 (2015), 7.

²⁰ *Ibid.*, 11.

²¹ *Ibid.*, 20.

value, it does not necessarily lose its worth completely – only shifting to another contextualizing value. Nonetheless, he argues that repatriation of auratic exhibits may in fact demean their worth in the long run, giving the example of Getty's *Aphrodite* which was repatriated from Malibu to a minor provincial museum in Sicily near its initial point of creation. Cronin argues that the auratic exhibit's distance of space and time from its material birthplace actually increased the value of *Aphrodite* to the everyman tourist in Malibu, but now it's current, less populous location in Sicily is only sought out by those already well-versed and familiar with the auratic exhibit.²² This is where the relevance of the 3D printed replica comes in. Instead of repatriating the auratic exhibit back to Sicily, Cronin is suggesting that the auratic exhibit was better served in alluring the public in Malibu than it is standing near its original spot of creation. This argument when broken down is essentially advocating for a situation where the appeal of the auratic exhibit's authenticity is maximized (in regard to its location and ability to generate foot traffic) while simultaneously suggesting that a 3D printed replica stationed near the original's birthplace is just as valid. The base of this seemingly contradictory viewpoint is in the ability of a 3D printer to so perfectly mimic a digitized original, that it renders distinguishability between the original and the copy difficult if not impossible to the human eye. As Cronin elaborates,

Three-dimensional scan and print technologies cannot reproduce an original object's aura, but they hold the potential to dilute, or even eviscerate, it. Imagine the Getty's bronze "Athlete" standing among a dozen or more visually and haptically identical copies of it. Each additional copy further undermines the legitimacy of the aura we ascribe to the original; what does it matter that one of these ten, twenty, or thirty bronzes was created 2000 years ago if I cannot identify it among the copies? While one could establish the original by resorting to non-visible or intangible evidence, why should such evidence affect the economic and physic value of a work that was created to be perceived entirely by human eyes and hands?²³

²² Ibid., 23.

²³ Ibid., 24.

This potential of its indistinguishability creates an interesting dialectic. One perfectly described by Jean Baudrillard who famously coined the term “hyperreal” to label the condition of being unable to distinguish between truth and falsehoods as well as reality and imagination. The implication this term brought forth was the notion of simulation, which suggests an interchangeability between an original and a copy since reality itself is uncertain to the human mind.²⁴ Baudrillard’s argument was based on the development of mechanical reproduction, thus the 3D printer’s ability to increasingly showcase the possibility of the hyperreal in actuality goes a step beyond what other forms of mechanical reproduction like film and photography could do. Cronin explores this possibility of the hyperreal from a grim outlook, suggesting the public domain of auratic exhibits leaves their holders within an existential crisis. As Cronin elaborates,

Digital technologies now threaten to undermine the economic potential of cultural artifacts like Michelangelo's David much as they have undercut profits from the producers of cultural artifacts like Hollywood movies and Silicon Valley software. Movies and software whose earnings have been sapped by unauthorized copying, however, involve the interests of living creators or direct descendants and are protected by copyright. There are no such lingering interests, on the other hand, in the case of Michelangelo or any of the creators of innumerable excavated and still buried cultural artifacts in Italy, whose works are in the public domain.²⁵

While these institutions seem open-minded now, Cronin suggests that they may yet attempt to impose contractual limits on those who replicate their auratic exhibits, creating a conflict where a changing public perception directly contradicts the concept of the public humanities. If everyone can have their own version of Michelangelo’s *David* after all, this threatens to render the cultural heritage sites and institutions obsolete. Cronin ultimately suggests the possibility of dematerializing the cultural objects in such a manner that the nations where these auratic exhibits

²⁴ Seio Nakajima, "Prosumption in Art," *American Behavioral Scientist*, Vol. 56, no. 4 (2012), 556.

²⁵ Cronin, "3D Printing," 35.

originate from would retain the authentic value of the original. Nonetheless, Cronin remains highly skeptical of the ideal of repatriation. In his own words,

If I owned an Apple computer—a cultural artifact of the United States—built by Steve Jobs himself, I would readily sell it to whoever places the highest value on its aura, buy a computer identical to the prototype, and pocket the difference. Why would contemporary Italians and Greeks be more attached to the innumerable, and often nearly indistinguishable, antiquities under their soil than I am to a computer built by a contemporary who lived in the country, state, and city in which I once lived? Antiquities, like Job's handmade computer, are chattels that embody intellectual investment. Given their age, they have no psychic or spiritual connection that is specific to twenty-first century Europeans, and now can be monetized and increasingly accurately replicated.²⁶

Yet it is also important to recognize that Cronin's own argument against repatriation can be just as easily turned back upon him. The theorist Katherine Hayles argues that technologies are social constructs, just as works of art and cultural heritage are considered to be.²⁷ Fiona Cameron, takes this a step further by arguing that digital objects are the result of coding and should be recognized as a form of materiality; going so far as to indirectly counter Cronin by suggesting that Michelangelo's *David* and its scanned, digital counterpart are both the result of human creativity – the ritualistic foundation of the aura.²⁸ As Cameron elaborates, “By understanding the modality and materiality of digital historical objects, new roles and a set of defining characteristics emerge beyond their role as servant to the “real” as representation, presence, affect, experience, and value in a museum context. Both modalities, the analog and the digital, are material objects by definition, each acting as testimony to its own history and origin, and hence authenticity and aura.”²⁹ Thus the replica of a 3D printer, the physical manifestation of a digital object, can easily gain its own aura compared to that of the original. 3D printed

²⁶ Ibid., 40.

²⁷ Fiona Cameron, "Beyond the Cult of the Replicant: Museums and Historical Digital Objects—Traditional Concerns, New Discourses," In *Theorizing Digital Cultural Heritage: A Critical Discourse*, ed. Fiona Cameron and Sarah Kenderdine, (Cambridge: MIT Press, 2007), 2.

²⁸ Ibid., 14.

²⁹ Ibid., 17.

replication then does not necessarily represent the evisceration of aura from the auratic exhibit but rather the possibility that these 3D printed replicas will receive their own auras, competing with the original.

Building off this theme of distributing a 3D printed replica of an auratic exhibit, is the concept of utilizing 3D printing to despatialize an exhibit from the museum entirely. Bernard K. Means argues that 3D printers are gradually becoming more accessible in the public sphere through academic institutions and makerspaces. Means argues that over time, the possibility exists for 3D printers to be incorporated into public schools and libraries, if not one's own home. The Virginia Historical Society among many other institutions are making their 3D models easily available online and thus providing anyone from a teacher to a history buff to essentially print out an exhibit of their own by replicating the scanned auratic exhibit. As Means' says on using cheaper 3D printed replicas,

This is particularly useful for schools and small institutions with limited space and even more limited budgets. These type of collections are not only useful for teaching developing scientists, but are themselves useful for making identifications in field or laboratory settings. Unlike real type specimens, 3D printed replicas can be easily and safely carried into the field and if made from plastic and therefore lightweight, one can actually carry hundreds of type specimens in a backpack or satchel.³⁰

This process essentially allows the institution to promote itself by providing a free service to those who would do the job of contextualizing the auratic exhibit for them. While these desktop 3D printers are not yet within the realm of producing the hyperreal, they expand the outreach of the institution that holds the auratic exhibit. Sarah Younan explores this liberating concept further through an act she refers to as "digital poaching". She coins the term specifically for artifacts and argues that the act is similar to creative appropriation, which changes the object's

³⁰ Bernard K Means, "Printing the Past: 3D Printed Artifact Replicas Aid in Research, Education," *R&D Magazine*, 2017, 22.

context and makes the object unique to the “poacher”. As she elaborates, “Photogrammetry is a digital form of cultural poaching, which harnesses “the participatory potential of the Internet and typifies modern popular culture” cultural institutions are mostly absent from these practices and may even be unaware that they are a source of material for poachers. These poached artefacts can take on new meanings, thus challenging institutional control and mediation of historical cultural materials”³¹. She studies two different projects, (Im)material Artefacts and Lincoln 3D Scans, which utilized desktop 3D printers in direct collaborations with several art museums. A major concession she points out is that the size and materials available limit the capabilities of desktop 3D printers. Unlike what institutions can print out, the desktop 3D printed object is smaller and often in plastic. She makes a comparison to souvenirs stating,

These 3D printed miniatures resemble souvenirs. While most souvenirs are bought during a tourist visit, the digital 3D models can be downloaded from the Internet. They are accessible anywhere at any time and are no longer necessarily connected to the experience of visiting a place or seeing an original object. They are souvenirs of visits not experienced but substituted through surrogate engagement with the digital reproductions. In one sense they offer nothing but virtual superficiality, but in another sense they can artificially widen the user’s experience of and engagement with heritage. After all, museum exhibitions are also simulations; substitutes for understanding and experiencing heritage in its original, historical context.³²

She does counter that 3D printed replicas can be edited and personalized, giving them their own uniqueness and so she argues that even through this removal and remixing of away from the auratic exhibit, the institution is still providing a service that stays within the boundaries of their mission statement.

While the concept of despatializing an exhibit from the museum may seem self-destructive, for larger institutions such an avenue for sharing their collections is seen as a net-

³¹ Sarah Younan, “Poaching Museum Collections Using Digital 3D Technologies,” *CITAR Journal*, Volume 7, No. 2, 26.

³² *Ibid.*, 27-28.

positive. Moritz Neumüller directly points to the Smithsonian Institution, who are only able to exhibit 2% of their 137 million artifacts at any one time through normal means of exhibition. As such, they have also been recently scanning and printing their collections. Enabling these 3D printed replicas to be exhibited in smaller museums, schools, and other public places. Following the trend of the Virginia Historical Society, they have also undertaken collaborative projects to exhibit the 3D printed replicas over their own collections. Red Eye on Demand, a company that specializes in prototyping emerging technologies, created a 3D printed replica of a Thomas Jefferson statue that was then exhibited within the National Museum of African American History and Culture. This action allowed the 3D printed replica to be placed within an exhibition that automatically contextualizes the exhibit within an entirely new and transformative framework. Allowing the replica to take on a deep and unique significance over the original it was from which it was digitized. Going a step further, Neumüller suggests that should museums initiate a paradigm change and reinvent the museum to incorporate 3D printed replicas, exhibitions could be made more accessible and inclusive to varying demographics of people. As Neumüller states, “3D Printing has the potential to become a standard technology for exhibition design, educational efforts and accessibility matters. Needless to say that visitors with visual impairments benefit the most from tactile reproductions and interactive installations, but so do children, the elderly and – in fact – the general public as a whole.”³³ Thus even for museums that are solely interested in upholding their auratic exhibits by sharing 3D printed replicas outside the walls of their institutions, there is also good reason in considering the use of 3D printed replicas within the walls of their own institutions as well.

³³ Reichinger M. Neumüller, A., Rist F. and, Kern C. “3D Printing for Cultural Heritage: Preservation, Accessibility, Research and Education,” In *3D Research Challenges in Cultural Heritage. Lecture Notes in Computer Science* by Marinos Ioannides and Ewald Quak (Berlin: Springer Berlin Heidelberg, 2014), 125.

Innovating Auratic Exhibitions with 3D Printing

Perhaps the biggest development that 3D printing brings to the public humanities is by renewing the touchable, tactile learning experience that once defined the progenitor museum experience. These earliest progenitors were not institutions but were rather the wealthy, flaunting storage rooms for collections of curiosities. These collections, often contained within a single grand hall within a vast manor, offered a near fantastical display of curiosities that fascinated the inquisitive repeatedly. The collectors were the first curators and their visitors were just as rich and curious as they were. Tours of these spaces were social experiences that often paired small groups of these guests with the collector himself who would show off the collections in person to build up their prestige on the social ladder. Paul F. Wilson among others in their study are quick to point out that collectors allowing guests to directly touch, handle, and examine artifacts was par for the course. Until of course, these collections became institutional and open to the public.³⁴ It is rather obvious to read elitism into this development. Yet Wilson is right to point to the necessity of protecting auratic exhibits from direct contact by nonprofessionals – even if that reason reinforces classist notions of safeguarding something of value from the masses. Nonetheless, Wilson coins what he refers to as the “glass-case paradigm” to describe the defining factor in how the public perceives and interacts with the cultural heritage exhibited in museums.

In light of the emergence of 3D printing Wilson points to study after study revealing that sensation of touch, the tactile experience, is the most influential and lasting element most remembered by museumgoers. Especially the young and impressionable. Ironically, the trend of science and children’s museums to create tactile and multisensory exhibitions is now being

³⁴ Paul F. Wilson et al, “Evaluation of Touchable 3D-Printed Replicas in Museums,” *Curator the Museum Journal*, Vol. 60 No. 4. (2017). 445.

largely reconsidered as a positive development that is beginning to breach into the public humanities by the widespread use of 3D printing. If replicas of auratic exhibits can be printed that are entirely expendable yet perfect at mimicking its shape, color, and texture; than these exhibits can once again be engaged in the same one-on-one manner that progenitor museums once offered to only a privileged few. In any case, most multisensory exhibitions still have faults as Wilson states,

Even where multisensory experiences have been exploited by these kind of museums they generally include objects or replicas made specifically for that exhibition or objects derived from teaching collections. While interesting in their own right, these objects lack the sense of awe that manifests itself in authentic objects of true antiquity. Understandably this is to preserve these key objects from degradation for without the expert hand of the curator to supervise, the risk of damage is significant.³⁵

While molding was once the usual process to create replicas of artifacts, Wilson argues molding is a time-consuming and dangerous process that 3D printing can easily bypass. After all, the 3D imaging or scanning process is one without risk since it involves no physical contact with the artifact. More so, 3D printed replicas can technically be made of the same material and style of the original while being wholly expendable. This particular factor is the inspiration of Wilson's study that asked museumgoers on their impressions of 3D printing in relation to increasing direct, tactile engagement with a replica artifact over the glass-case paradigm.³⁶

Wilson's study was conducted at the Oxford University Museum of Natural History and involved a series of seventy-four interviews about the reception of utilizing touchable, 3D printed replicas of artifacts as a permanent addition to the exhibition space. Three major findings resulted from this process: Firstly, while most sampled were aware of 3D printing; most, though

³⁵ Ibid., 446.

³⁶ Ibid.

especially the youngest age category,³⁷ were ignorant of the actual operational process or its greater implications on society. Secondly, responses were extremely positive that touchable 3D printed replicas would enhance the museum experience for reasons of increasing interactivity and connection with the subjects. Lastly, a third of the interviewees admitted that the inclusion of 3D printed replicas would not actually change their rate of museum attendance, which suggests that the idea is not entirely revolutionary or indicative of the attraction of the museum experience.³⁸

To address these results, the evaluation advocates for a number of measures to be undertaken by museums. Educating the public on the mechanics and nuances of 3D printing is a must, especially if that can be incorporated into the exhibition. As the study states, “As a consequence, it may be necessary to take this lack of understanding into account when designing exhibits that incorporate touchable 3D printed replicas. Visitors should be made aware that the touchable items are indeed 3D prints and should include a simple explanation of how 3D printing works.”³⁹ Wilson goes on to suggest the necessity of these touchable 3D printed replicas to be made of comparable enough material to accurately simulate the original. The study also addresses the interviewees’ perception of the authenticity of the original; ultimately concluding that it doesn’t appear integral to the interactive experience, especially if enough contextualizing knowledge is provided and the replica is detailed enough to substitute in examining up close. As the study details, “They found that authenticity takes a backseat to the opportunity to gain knowledge, constituting a contrast to the feedback of visitors from this study. Given this contrast combined with large void on the topic of the physical properties of tactile replicas and potential

³⁷ Which ranged from eight to seventeen years old, an interesting counterpoint to the stereotype that the youth lead tech culture by being the earliest adopters.

³⁸ Ibid., 456.

³⁹ Ibid., 459.

touchable 3D prints.”⁴⁰ The study overall recommends further research towards these particular recommendations but is fairly indicative that 3D printing can at least supplement auratic exhibits in the public’s perception.

Théophane Nicolas also agrees with the importance of providing access to 3D printed replicas of cultural heritage within the museum setting. While the auratic exhibit is valuable in engaging the public, those of a tiny scale are difficult to display or retain focused interest. Nicolas argues that by continuing to ignore this problem, museums are in fact decontextualizing an artifact’s functionality in favor of its aesthetic appeal alone. As he says, “When artifacts have been preserved, it is their context of use that is no longer accessible because this is related to an activity that no longer exists, or requires additional objects to operate.”⁴¹ 3D printed replicas however can provide both tangibility and functionary context to museumgoers; allowing visitors to study objects up close that would allow them to notice details otherwise difficult to take in from the opposite end of an exhibit case.⁴² This opens the way for a radical shift in how a museum can carry out pedagogy. Rather than an exhibition simply relaying didactic text, images, sound, and video to a museumgoer – the pedagogical experience can be further improved by allowing a museumgoer to actually utilize a 3D printed replica of an artifact in a space that was specifically designed to impart an artifact’s contextual functionality. This not only gives the museumgoer a unique firsthand experience, but helps to change how the public engages with the museum without relying on the reverence for the auratic exhibit to convey such meaning.

This prospect of introducing tangibility to auratic exhibits via 3D printing can also apply to the art world. Megan Hancock writes in her article that the average time a museumgoer

⁴⁰ Ibid., 460.

⁴¹ Théophane Nicolas et al, “Touching and Interacting with Inaccessible Cultural Heritage,” *Presence: Teleoperators and Virtual Environments*, 24, no. 3 (2015), 265.

⁴² Ibid., 266.

engages a piece of artwork for is about thirty seconds. This is the basis for her coverage of a number of experimental workshops in art museums such as the British Museum and the Samsung Digital Discovery Center (among others) that implement 3D printing to actually allow visitors to recreate scale models of artwork; with the Art Institute of Chicago even allowing them to take the replica home with them as souvenirs.⁴³ The process is a relatively straightforward one for the public, as Hancock describes the process as, “Using 123D Catch (a free photo app for smartphones), visitors can take pictures of objects in the gallery that automatically stitch together and create a 3D file. These files can be loaded into basic editing software and, using the scan as a base, create a physical, 3D printed model. This process truly moves museum galleries from quiet chambers to exciting and innovative makerspaces.”⁴⁴ Of especially worthy note here is the financial inventive museums would likely see in capitalizing on having tourists buy into these workshops as part of the museum experience. Once again, there is evidence that by surrendering the auratic exhibit’s prominence, the museum is able to discover new avenues in transforming the traditional exhibition space – all the while remaining loyal to their institution’s particular mission regarding their collections.

Further addressing the topic of 3D printing workshops in the museum, Younan touches specifically with working with third party organizations. Specifically through “hackathons”, events within the open source makerspace community, that have been incorporated into the museum experience. These are all day events in which programmers, designers, digital media artists, and hackers collaborate within a short span of time to create software. As Younan describes, “Hackathons have become a popular method for organizations to experiment with

⁴³ Megan Hancock, “Museums and 3D Printing: More Than a Workshop Novelty, Connecting to Collections and the Classroom,” *Bulletin of the Association for Information Science and Technology*, Vol. 42, No. 1 (2015). 32-34.

⁴⁴ *Ibid.*, 33.

digital media. Some hackathons are intended for educational or social purposes. At other times, the goal is to create solutions such as websites, applications or usable software, to a broader challenge or goal outlined by the host.”⁴⁵ Younan describes a few of these museum led hackathons, one of them taking place in 2012 at the Metropolitan Museum of Art. Attendees were invited to digitize, remake, and recreate museum artifacts from their collections. Unlike tourist friendly workshops however, these hackathons are not open to just anyone. They are limited in attendance and very exclusive in scope since their nature dictates them to be intensive, often overnight experiences. Since they take place within the museum, they are also heavily supervised by museum staff so while there is a lot of potential in these events for experimentation and recreation, Younan believes they are still relatively untapped in how this can be translated to a museum’s regular set schedule.

The idea of using 3D printer workshops for creative remixing is not just limited to art museums. Hannah Turner conducted a similar workshop for a research project at Bata Shoe Museum in Toronto, Canada in order to study how children were able to learn about the public humanities through 3D printing. The authors sought to answer whether the construction and design process directly contributed to a greater historical and material understanding of the shoe. Among other concerns, such as whether children were fully capable of comprehending the 3D printing process, the authors also sought to learn how compatible the workshop was with traditional museum education classes. The results they present seem to reinforce the importance of creativity in the process. As they say,

Simply, children were able to understand and repeat knowledge they learned both about the history of shoe buckles and the 3D design process simultaneously. Further, when asked about objects they created, participants noted that they chose designs and letters to

⁴⁵ Sarah Younan, “Towards a Digital Dream Space: How can the use of digital 3D scanning, editing and print technologies foster new forms of creative engagement with museum artefacts?”(PhD Thesis, Cardiff Metropolitan University, 2015), 28.

personalize their objects, indicating a propensity to use 3D technologies for creative, rather than merely instrumental, purposes. This also potentially showed that children were taking lessons learned from the historical introduction about the use and purpose of shoe buckles – as indicators of personal fashion and style.⁴⁶

Turner argues that this in particular delivers insight into how similar workshops can be utilized in other museums. If these institutions can deliver a hands-on, creative experience that built upon recognizing the artifact's construction and its contextual functionality, than more of these 3D printed workshops can be used to supplement the traditional exhibition experience and expand the resource of pedagogical tools. Though Turner recommends further research, these workshops have the potential to alleviate the loss of the auratic exhibit.

Multisensory exhibitions go beyond just basic tactile experiences and workshops however. Virtual reality is a similarly emergent technology in the 2010's in usage alongside 3D printing, and the two are increasingly paired together to create entirely new experiences. This concept of using virtual simulations that incorporate physical elements (such as objects) into the experience is called mixed reality. Nicolas presents a case study that attempted to utilize VR to simulate an Iron Age settlement in Britany, France using the 3D replicated remains of weighing scales. Users were immersed into a weighing activity with VR headsets that simulated an ancient steelyard and were then tasked to utilize the 3D printed replica scales to work the steelyard balance. The weighing scales were 3D printed out of the same material as the auratic exhibit to hold its same weight and texture. This created a MR experience that accurately simulated and showcased the contextual functionality of the auratic exhibit. As elaborated upon by Nicolas,

In this case, the 3D printed object becomes a tangible interface to recreate a human activity. The association of physical representation of an object and its context of use increases the understanding of past activities. Handling an artifact or its copy, and trying to imagine how it was used, is generally not sufficient to apprehend the physical reality of the gesture associated with the manipulation of the object in its context. The simulation

⁴⁶ Hannah Turner et al, "Using 3D Printing to Enhance Understanding and Engagement with Young Audiences: Lessons from Workshops in a Museum," *Curator: The Museum Journal* 60, no. 3 (2017), 329-330.

of the steelyard, with a realistic physical behavior, allows the study of the different steps of weighing.

This can be seen as a total transformation of the exhibition. If a museum is traditionally expected to interpret the auratic exhibit for the public's benefit, the utilization of 3D printing in combination with mixed reality simulation exists to further that goal; all the while shifting the museumgoer away from a glass-case paradigm and towards a tactile experience that involves direct engagement with the 3D printed replica.

This multisensory experience using 3D printed replicas also expands the museum going experience to people with disabilities as well. Particularly the blind and visually impaired, who engage the world tactilely, more so than one who relies on sight. The use of 3D printed replicas allows them to physically examine exhibits in lieu of visualization. As Scopigno suggests, "This can be done by simply producing a touchable replica or by designing/adopting methods that enhance the perception of the shape detail over the surface of the replica. Interesting methodologies have been designed to also transform paintings or photographs into 3D models that can be experienced by visually impaired people by physical replicas. The use of colored relief printing technologies can be effective to implement these approaches."⁴⁷ Another innovation to assist in making multisensory exhibitions accessible is the "Tooteko", a smart ring that works to create an audio-tactile experience where 3D printed replicas are outfitted with near-field communication sensors that detect the ring as the user's finger rubs across the 3D printed replica's surface. Multiple sensors are outfitted to provide a completely contextualized experience detailing specific sections of a work.⁴⁸ As Agnano says,

⁴⁷ R, Scopigno et al, "Digital Fabrication Techniques for Cultural Heritage: A Survey," *Computer Graphics Forum*, Vol. 36, No. 1, 12.

⁴⁸ F. D. Agnano et al, "Tooteko: A Case Study of Augmented Reality for an Accessible Cultural Heritage. Digitization, 3D Printing, and Sensors for an Audio-Tactile Experience," *The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*, Vol. XL-5/W4 (2015), 207.

The system's goal is to intensify and simplify the relationship with the visitor, always more inclined to using interactive technologies even in the cultural field. Through making available different engineered reproductions of the works for the users, the visitor will benefit from a versatile, multilingual guide instrument, with different levels of depth studying, able to provide for all kinds of visitors, starting from the visually impaired, as an addition to the reading of the work, favoring the experience of a direct contact, even if solely through a 3D reproduction, with the art work.⁴⁹

3D printing thus allows any number of replicas to be accessible to a group that could not normally engage with the auratic exhibit beforehand. To these persons, already used to living in the world by only touch and sound, the 3D printed replica with its potential for detailed textures would allow them to further engage with the public humanities.

Conclusion

The 3D printed replica represents a fundamental change to material culture and the public humanities. The auratic exhibit is built upon the ideas of the aura, cultural mass, and the inalienable possession, yet today it is positioned more as a mile marker for the 3D printer to overcome than something once thought to be impossibly beyond reach. Institutions, comprised and organized by people, have always grappled with emerging technologies. Especially when they disrupt a cultural norm. Yet in responding to the emergence of 3D printed replication, these institutions are transforming the landscape in how the public even perceives the museum. So long as the museum's mission statement is followed, this transformation does not represent an undoing of the public humanities but rather the decoupling of the museum reliance upon the auratic exhibit. The 3D printed replica of an auratic exhibit currently exists within a contradictory framework of supplantation and supplementation in relationship to the auratic exhibit. This should be thought of nothing less than an opportunity for museums in the public humanities, since they can totally transform how they engage with the public before 3D printing

⁴⁹ Ibid., 208.

becomes a commonality. In replicating and sharing the auratic exhibit, the museum is despatializing the traditional exhibition while also providing tactile, multisensory, and accessible new exhibitions experiences. These experiences, whether utilizing workshops or mixed reality simulations further a museum's mission to help the public reconnect, reexamine, and reevaluate its relationship with the past and their cultural heritage. The 3D printed replica does not represent the demise of the auratic exhibit, but rather further aids in its preservation.

Bibliography

- Agnano, F. D., C. Balletti, F. Guerra, and P. Vernier. "Toteko: A Case Study of Augmented Reality for an Accessible Cultural Heritage. Digitization, 3D Printing, and Sensors for an Audio-Tactile Experience." *The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*. Vol. XL-5/W4. (2015). 207-213.
- Benjamin, Walter. "The Work of Art in the Age of Mechanical Reproduction." in *Illuminations* edited by Hannah Arendt. Translated by Harry Zohn. New York: Schocken Books, 1969. 1935.
- Burch, Stuart. "A Virtual Oasis: Trafalgar Square's Arch of Triumph." *ArchNet-IJAR: International Journal of Architectural Research*. 11, no. 3. (2017), 58-77.
- Cameron, Fiona. "Beyond the Cult of the Replicant: Museums and Historical Digital Objects—Traditional Concerns, New Discourses." In *Theorizing Digital Cultural Heritage: A Critical Discourse* edited by Fiona Cameron and Sarah Kenderdine. 1-22. Cambridge: MIT Press, 2007.
- CNN. Palmyra's Arch of Triumph printed in 3D." <https://youtu.be/SKCpnEqF4bE?t=1m25s>
- Cronin, Charles. "3D Printing: Cultural Property as Intellectual Property." *The Columbia Journal of Law & the Arts* vol. 39, no. 1 (2015). 1-40.
- Flynt, Joseph. "A Detailed History of 3D Printing." *3DInsider*.
<http://3dinsider.com/3d-printing-history/>
- Hancock, Megan. "Museums and 3D Printing: More Than a Workshop Novelty, Connecting to Collections and the Classroom." *Bulletin of the Association for Information Science and Technology*. Vol. 42, No. 1. (2015). 32-35.
- Harvey, David. *A Brief History of Neoliberalism*. New York: Oxford University Press, 2005.
- Harvey, David. *The Condition of Postmodernity: An Enquiry into the Origins of Cultural Change*. Massachusetts: Blackwell Publishing, 1990.
- Matthes, Elrich Hatala. "Palmyra's ruins can rebuild our relationship with history." March 8, 2017. *Aeon*,
<https://aeon.co/ideas/palmyras-ruins-can-rebuild-our-relationship-with-history>
- Means, Bernard K. "Printing the Past: 3D Printed Artifact Replicas Aid in Research, Education." *R&D Magazine*. 2017. 20-22.

- Nakajima, Seio. "Prosumption in Art." *American Behavioral Scientist*. Vol. 56, no. 4 (2012), 550-569.
- Neumüller M., Reichinger A., Rist F., Kern C. "3D Printing for Cultural Heritage: Preservation, Accessibility, Research and Education." In: Ioannides M., Quak E. (eds) *3D Research Challenges in Cultural Heritage. Lecture Notes in Computer Science*, vol 8355. Springer Berlin Heidelberg. (2014): 119-134.
- Nicolas, Théophile, Ronan Gagne, Cédric Tavernier, Quentin Petit, Valérie Gouranton, and Bruno Arnaldi. "Touching and Interacting with Inaccessible Cultural Heritage." *Presence: Teleoperators and Virtual Environments* 24, no. 3 (2015): 265-277.
- O'Neal, Bridget Butler, "Palmyra's Arch of Triumph Replica Unveiled in Trafalgar Square—Next, On to Dubai & New York." *3DPrint*, April 20, 2016.
<https://3dprint.com/130628/palmyra-arch-traffic/>
- Scopigno, R., P. Cignoni, N. Pietroni, M. Callieri and M. Dellepiane. "Digital Fabrication Techniques for Cultural Heritage: A Survey." *Computer Graphics Forum*, Vol. 36, No. 1. 6-21.
- Simmons, Erik. "Triumphal Arch of Palmyra Under Construction." *Vimeo*.
<https://vimeo.com/161046225>
- The Institute of Digital Archaeology*. "Triumphal Arch." <http://digitalarchaeology.org.uk/media/>
- Turner, Hannah, Gabby Resch, Daniel Southwick, Rhonda McEwen, Adam K. Dubé, and Isaac Record. "Using 3D Printing to Enhance Understanding and Engagement with Young Audiences: Lessons from Workshops in a Museum." *Curator: The Museum Journal* 60, no. 3 (2017): 311-333.
- Weiner, Annette B. "Inalienable Possessions: The Forgotten Dimension." In *Inalienable Possessions: The Paradox of Keeping-While Giving*. By Annette Weiner. Oakland: *University of California Press*. 1992.
- Wilson Paul F. Janet Stott, Jason M. Warneet, Alex Attridge, M. Paul Smith, and Mark A. Williams. "Evaluation of Touchable 3D-Printed Replicas in Museums." *Curator the Museum Journal*, Vol. 60 No. 4. (2017). 445-465.
- Younan, Sarah. "Poaching Museum Collections Using Digital 3D Technologies." *CITAR Journal*. Volume 7, No. 2 (2015). 25-32.
- Younan, Sarah. "Towards a Digital Dream Space: How can the use of digital 3D scanning, editing and print technologies foster new forms of creative engagement with museum artefacts?" PhD Thesis, Cardiff Metropolitan University, 2015.