

digital cultural heritage: FUTURE VISIONS

Edited by Kelly Greenop and Chris Landorf

Papers presented at the *digital cultural heritage: FUTURE VISIONS* Conference
19–20 April 2017 in Brisbane, Australia
<http://digitalculturalheritageconference.com/>

Clarke, A and Paine, A (2018)

The rhetoric of reproduction: built heritage in a digital age.

In K Greenop and C Landorf (eds) *Proceedings of digital cultural heritage:
FUTURE VISIONS*. Brisbane:

Architecture Theory Criticism History Research Centre,
School of Architecture, The University of Queensland,
pp 112-130.

ISBN 978-0-646-98233-5

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The convenors of the *digital cultural heritage: FUTURE VISIONS Conference* acknowledge the generous support and sponsorship of the Architecture Theory Criticism and History Research Centre at The University of Queensland and the Ian Potter Foundation. Thank you also to the peer reviewers who gave their time and expertise to the refereeing of papers, the State Library of Queensland who hosted the event, and Carmen Armstrong who provided invaluable project management support.

The papers published in these proceedings are a record of the conference mentioned on the title page. They reflect the authors' opinions and, in the interests of timely dissemination, are published as submitted in their final form without change. Their inclusion in this publication does not necessarily constitute endorsement by the editors.

Editors: Kelly Greenop and Chris Landorf

Design and Production: Mark Fletcher

Publisher: Architecture Theory Criticism and History, The University of Queensland

The Conference Convenors received a total of 44 abstracts. Abstracts underwent a double-blind peer review by two members of the Conference Organising Committee. Authors of accepted abstracts (32) were invited to submit a full paper. All submitted full papers (18) were again double-blind peer reviewed by two reviewers. Papers were matched as closely as possible to referees in a related field and with similar interests to the authors. Sixteen full papers were accepted for presentation at the conference and a further 6 papers were invited to present based on submitted abstracts and work-in-progress. Revised papers underwent a final post-conference review before notification of acceptance for publication in these conference proceedings.

Please note that papers displayed as abstracts only in the proceedings are currently being developed for submission to a digital cultural heritage special edition of an academic journal.

Amy Clarke

University of the Sunshine Coast

Ashley Paine

The University of Queensland

The rhetoric of reproduction: built heritage in a digital age

Abstract

In recent years, digital heritage has emerged as an important new field of research and practice, with an implicit ambition to record, conserve and even reconstruct culturally significant sites and artefacts threatened by war, climate change, natural disasters, development and neglect. Digital heritage initiatives have been enthusiastically promoted and adopted by government bodies, institutions and philanthropic organisations from around the world. Despite its allure, the application and utility of preserving, managing and reproducing built heritage via digital technology remains largely untested, and carries with it risks that may ultimately undermine the practice altogether. Drawing from recent examples such as the Institute of Digital Archaeology (IDA)'s replica Palmyra Arch, and Factum Arte's facsimile of Tutankhamen's Tomb, this paper identifies some of the particular challenges raised by the physical replication of heritage using digital technologies. Issues such as the quality of reproduction, the motivations for such projects, and unintended outcomes (e.g. neglect, complacency) are considered, as are more philosophical questions such as the revision of history. As such, the paper takes on a critical and provocative future vision of digital heritage technology and its use in replication, by highlighting some of the threats such practices may pose to the very cultural heritage it aims to protect.

Keywords: Digital heritage replication; Palmyra; Tutankhamen

Introduction

The past decade has seen a proliferation of digital heritage organisations and initiatives gaining media coverage and industry acclaim for their efforts. When news cycles are filled with reports of war, unchecked climate change, conflict, and unstable economic systems, the use of digital documentation and reproduction to 'protect' cultural heritage offers a glimmer of hope for increasingly dark times. The fear of slow, incremental loss that propelled heritage conservation over past centuries has evolved into a paralysing mix of desperation and resignation: we are more aware than ever that heritage can—and will—be destroyed more rapidly today by natural and manmade forces, regardless of diplomatic and industry protests to the contrary. Digital documentation and 3D printing technologies have flourished in this anxious atmosphere; the optimistic rhetoric that surrounds these programmes offers reassurance that heritage will be 'saved' for all humankind, present and future. For precisely this reason, digital documentation, archiving and replication have been launched into with altruistic aplomb by government bodies, heritage institutions and philanthropic organisations. However, their application and utility in preserving, protecting or reconstructing built heritage remains largely untested, and carries with it risks that may ultimately undermine the practice altogether.

After a decade or so of activity, it is now possible to reflect on the limitations of this technology and the problems of its accompanying rhetoric. While some critical debates are beginning to grapple with the socio-political issues of gathering digital information (including its ownership, accessibility and control, often by foreign organisations and government bodies) as well as the technical problem of its long-term storage, less attention has been paid to its application. This includes questions regarding the quality, and quantity, of digitally-facilitated reproductions, not to mention the unintended consequences of such practices on the experience, maintenance and protection of our cultural heritage.

Certainly, as the technology that enables increasingly accurate documentation and reproduction has forged ahead, heritage conventions and standards of practice have failed to keep pace. Emerging philosophical questions also warrant greater attention: should the decay and destruction of a heritage site be the final chapter in its story, or are reproductions acceptable in certain circumstances and, if so, which ones? As public criticism of the Institute of Digital Archaeology (IDA)'s Palmyra Arch project has recently demonstrated, some of these issues have begun to surface, revealing a seam of discord within the apparently universal optimism with which digital heritage programmes have been championed. It has also made manifest the gaps that exist between the promotion of digital heritage as a kind of insurance policy for international built heritage, and the practical challenges of attempts at physical reconstruction. This rhetoric will undoubtedly unravel further as applications of digital heritage technologies are expanded.

The issue of rhetoric will be returned to at the end of this paper. First, however, the discussion will take a polemical view on current digital heritage practices, to speculate on several known and potential pitfalls in their application, drawing on the recent efforts of two internationally recognised organisations, IDA and Factum Arte. While the issue of copies and replicas has long been a subject of fascination for historians and conservation practitioners, in this paper we focus specifically on some of the philosophical questions that digital reproduction raises and indeed, that will need to be addressed in the near future. Accordingly, three recent examples of digitally-assisted reproduction by IDA and Factum Arte will be briefly analysed, along with the accompanying rhetoric and public criticisms of these projects. It is our intention to use these examples to raise broader questions about conservation in the digital age (rather than to provide answers). While critical in approach, the paper recognises that the discipline of digital heritage is only at the beginning of a highly ambitious project intended to record and safeguard data for millennia to come. It also acknowledges that many within the industry, including the two subject

organisations of this paper, are involved in ongoing research to advance both technical practices and disciplinary standards. Nevertheless, the relative longevity of IDA and Factum Arte within this young industry has provided some of the first demonstrated applications of developing technology, and hence an opportunity to discuss some of the critical issues at stake in heritage reconstruction. In particular, IDA has attracted mixed reviews for its 'activist' Palmyra Arch 3D printing project and has plans to continue this service in the future, raising practical concerns about quality, but also motivation. Factum Arte, on the other hand, has established a reputation for intricately detailed replications but, in achieving such quality, its work prompts broader philosophical reflection. The respective challenges that each presents is examined below.

To print or not to print: Institute for Digital Archaeology (IDA) and the Palmyra Arch

It is perhaps not surprising that a number of digital heritage organisations are currently focusing their documentation efforts on the conflict-stricken Middle East. IDA, however, has taken the further step of making a physical reconstruction: namely, a one-third-scale replica of Palmyra's Triumphal Arch (Figure 1), which was destroyed by ISIS militants in 2015. Made using digital cutting and printing technology, the replica Arch was displayed in London (Figure 2), New York and Dubai in 2016, and plans for its future installation in Syria have circulated (IDA 2016a & 2016c). While it is likely that we will witness more such reconstructions in coming years, there is little international regulation at present to set the criteria for their quality, quantity or context. Moreover, there is ongoing debate in the heritage sector on the appropriateness of manufacturing reproductions at all, fuelled by conflicting interpretations of international instruments, including the 1964 *Venice Charter* (Stanley-Price 2009, 32). While IDA's high profile project makes an important contribution to this debate, it is the confusion and controversy that has surrounded the reconstruction of the Palmyra

Arch that is of interest to this paper. In particular, the project highlights two interconnected issues: the quality of the replication, and the motive for its undertaking.



Figure 1. Palmyra's Triumphal Arch in 2007. (Source: Jerzy Strzelecki, Wikimedia Creative Commons 3.0).

Founded in 2012 by Roger Michel, IDA has connections with Harvard and Oxford Universities, the Dubai Future Foundation and UNESCO's World Heritage office, amongst others (IDA 2016b), and describes one of its key focuses as 'On-Site Reconstructions'. Despite this, global press coverage of the Palmyra Arch project has revealed much uncertainty about the scope of the project and the materials and processes used. Unable to document the Arch with laser scanning technology, IDA relied instead on a large number of photos to create what it claimed was an 'accurate' digital model of the structure (Leigh 2016, D5), complete with features that would be 'completely indistinguishable



Figure 2. IDA's replica Palmyra Arch in London, 2016. (Source: Garry Knight, Flickr Creative Commons 2.0).

from the original' (Roger Michel, quoted in Jenkins 2016, 31). On its website, IDA describes the Arch as being a one-third-scale reproduction that was 'produced using state-of-the-art 3D technology,' including a 'seven axis mechanical arm which carved the arch out of pure Egyptian marble' (IDA 2016a). It had previously been reported that the Arch would be assembled from 3D printed parts made of powderstone (Dunn 2015). There was also uncertainty over the design and number of arches being replicated: it was first announced that two replicas of the entrance archway of the Temple of Bel would be simultaneously installed in Trafalgar Square and Times

Square, and that smaller replicas might be made for display in museums (Basulto 2016; Richardson 2016). IDA's Director of Technology, Alexy Karenowska, was also quoted explaining that once the data was put online it would be open-access so people could print their own models (Basulto 2016). As of December 2016, this has yet to come to fruition.

Some of the confusion that has surrounded the form and scope of IDA's Palmyra Arch is understandable: the use of new technology on such an ambitious project is bound to involve some trial and error. The project was also carried out in the public eye, and without detailed laser-scan data from the original. Yet, for some, such as Adam Lowe of Factum Arte (a competitor of IDA), these limitations were not enough to justify the Arch's final appearance. In a 2016 'review' of the London installation, Lowe described the replica Arch as being 'a uniform yellowish material and roughly modelled from photographs.' He added later that 'A cursory comparison between the original and the replica confirms that it is an approximate copy and not a facsimile or replica. [...]he copy doesn't match the original in terms of detail, decoration and colour let alone scale' (Lowe 2016). Others were more blunt. Kay Kohlmeyer, an archaeologist familiar with the Arch, asserted that the model looked more like 'a Disney World display' than the original (quoted in Garaev, 2016). Such criticism demonstrates that even for IDA, an organisation with connections to institutions like Harvard and Oxford, one of the major challenges in the 3D printing of heritage is quality. The problem is unnecessarily exacerbated when paired with rhetoric that encourages an expectation that the outcome will be accurate, authentic or, as Michel claimed of the Arch, 'completely indistinguishable from the original' (quoted in Jenkins 2016, 31). Though such goals are admirable, the reproduction Palmyra Arch and its criticisms highlight the need for more clear and measured rhetoric in relation to the current possibilities and limitations of replication.

IDA's motivations for the project have also been brought under some scrutiny. When first announced, the reproduction of the Arch was promoted as a 'call

to action' (Dunn 2015), intended 'to draw international attention to the global crisis surrounding the looting and despoliation of cultural heritage objects and architecture' (Lidguard 2015). IDA's Michel claimed, 'We are saying to them if you destroy something we can rebuild it again. The symbolic value of these sites is enormous, we are restoring dignity to people' (quoted in Dunn 2015). Some applauded the defiant, activist nature of the Arch project: Boris Johnson, then Lord Mayor of London, championed the replication as giving 'two fingers to Daesh' (quoted in Clammer 2016). Other commentators were less convinced of the purpose and efficacy of the Arch. Archaeologist Tim Schadla-Hall remarked: 'It seems to me it's a bizarre expenditure of money, possibly with worthy but misinformed aims, to promote something which isn't a real past, in an entirely reproduced form' (quoted in Richardson 2016). By contrast, the potential of the project to detract attention from Syria's humanitarian crisis was central to Joseph Willits' critique: 'I cannot help but feel this project plays a role in cementing the idea that Syria's monuments and heritage are far more important than its people' (quoted in Taylor 2016).

Collectively, these criticisms point to a bigger issue: that digital documentation and replication may be used, or at least be seen to be used, for any number of personal, political, institutional or financial gains, all the while obscuring other more important issues. And if, as Lowe and Kohlmeyer have alleged, the replica Arch was significantly different from the original, what purpose does this replica serve in promoting an inaccurate and incorrectly scaled image of the lost structure to international audiences? While the Arch project has successfully brought attention to the destruction of built heritage in Syria, it has yet to achieve tangible outcomes like heritage site protection or humanitarian assistance for the Syrian people. Moreover, ongoing conflict has so far prevented IDA from installing the Arch near Palmyra as promised (Richardson 2016); and as Emma Cunliffe (2016) has noted, there is conjecture as to whether any reproductions should be allowed at Palmyra at all. What is certain is that the project has succeeded in publicising the products and services of IDA, an

outcome that Michel openly acknowledged when he suggested that the Arch would be 'proof of [IDA's] competency to do these things' (Richardson 2016). This leaves the Institute, and indeed any other organisations that engage in similarly high-profile reproductions, vulnerable to the perception of ulterior motives behind such altruistic, activist endeavours.

Blurring the boundaries between fake and real: Factum Arte, *The Wedding at Cana* and Tutankhamen's Tomb

These debates over issues of quality and motivation for reproduction are not easily settled. Certainly, with regard to the former, it is not simply a matter of waiting for enhanced technical capacities—quality will often be constrained by available skills, materials, time and cost, requiring judgements to be made on the necessary verisimilitude of a given reproduction, and its similarity to an original artefact. Besides, copies with an exceptionally high degree of accuracy are already achievable—albeit at a price—and open up a further suite of difficult questions concerning the authenticity of people's experiences in the presence of such replicas, as well as issues of complacency and neglect in heritage conservation. Acknowledging that these are deeply philosophical and largely hypothetical questions, here the paper shifts focus to ground the final part of the discussion in two examples of 3D replication undertaken by Factum Arte (and its partner Factum Foundation) in an effort to explore these concerns. The replicas—a copy of Paolo Veronese's painting *The Wedding at Cana* (1563, replica installed 2007) and a facsimile of Tutankhamen's Tomb (c. 1323 BCE, replica installed 2014)—have been generally well-received by heritage professionals and commentators and, interestingly, both exist simultaneously with the original works.

Factum Arte was formed in the early 2000s under the direction of Adam Lowe (Factum Arte 2016a), while its not-for-profit sister organisation, Factum Foundation, was founded in 2009 (Factum Foundation 2016a). Factum Arte undertakes commercial commissions and charitable projects, with much of

the funding for the latter coming from the coffers of its Foundation and public donations (Factum Arte 2016d; Factum Foundation 2016e). Like IDA, Factum Arte has collaborated with a range of heritage organisations and authorities including the British Museum, Musée du Louvre and the government of Egypt (Factum Arte 2016a); its services include software and hardware design, documentation using laser scanning and photogrammetry, reproduction (3D printing and casting) and installation (Factum Arte 2016c). The replications of *The Wedding at Cana* and Tutankhamen's Tomb were some of the organisation's earliest projects; more recent work includes the Theban Necropolis Preservation Initiative in Egypt and the Cross-River Monoliths Project in Nigeria (Factum Foundation 2016c).

Originally displayed in a monastery on the island of San Giorgio Maggiore in Venice, *The Wedding at Cana* was looted by Napoleon's army in the late eighteenth century and taken to Paris. It is now one of the Louvre's many prized attractions. With the Louvre's permission, Factum Arte began digitally documenting Paolo Veronese's almost 70 square metre painting (Figure 3) in late 2006 (Factum Arte 2016b). In 2007 an intricately detailed replica was printed and installed back in the artwork's original position in the Venetian monastery (Caliari 2016). The result, at least in the eyes of the commissioning foundation's director, Pasquale Gagliardi, was a replica with 'all the lines, colour gradations, and even the flaws and signs of wear of the original canvas' (quoted in Owen 2007, 49). As with IDA's Palmyra Arch project, *The Wedding at Cana* replica was not without its critics, but in this case the concerns raised were largely of a philosophical nature. In a piece for the *New York Times*, Povoledo (2007, B7) opened with the question, 'Can – and should – technology right a historical wrong?' Cesare De Michelis, of the University of Padua, suggested such work was 'devastating and "immoral" if it claims to substitute the original, just like cloning human life' (quoted in Povoledo 2007, B7). Lowe's response to these concerns was to argue that the work was 'not a clone but a deep and detailed study' (quoted

in Povoledo 2007, B7)—a view shared by art critic Corriere della Sera who described the replica as 'a turning point in art' (quoted in Jobey 2013, 30).

While Factum Arte's success with *The Wedding at Cana* replica may be applauded, its criticisms should not be dismissed. And, even though the subject in



Figure 3. Paolo Veronese's *The Wedding at Cana* on display in the Louvre, 2014. (Source: Nathanael Burton, Wikimedia Creative Commons 2.0).

discussion here is a painting, these criticisms reveal some of the challenges for digital heritage replication more generally. Perhaps the most difficult question is whether the placement of a replica in its original context following theft, damage or destruction, effectively erases or corrects complex political, social and cultural histories. At the very least, we should consider whether the replacement of works like *The Wedding at Cana* obscure these important parts of the object's own story. Additionally, the act of duplication places two (or more) iterations of the same artefact in opposition to one another: why bother visiting an original in the wrong context when a high-quality replica in the 'right' context can provide a more

fulfilling experience? Factum Arte's Lowe claimed that when *The Wedding at Cana* replica was unveiled, 'about 30 per cent of the people there just burst into tears. Here were a lot of cultured people who knew their history, who knew what they were looking at, and who felt a strong emotional reaction at something which they knew to be a copy' (quoted in Aspden 2014). And what, might it be asked, would happen to this highly effective replica if the Louvre eventually returned the original artwork to the Venetian monastery? Would the replica, which has itself become an emotionally charged and historically significant cultural artefact—a new original in its own right—be forgotten or destroyed? As 3D heritage replication expands, we must be mindful that this technology has the potential to instigate multiple histories of a single heritage structure or artefact. These histories may even compete with, and contradict, one another until, as Umberto Eco once imagined, notions of 'real' and 'fake' are effectively meaningless (1998, 7).

These are not the only philosophical conundrums unearthed by 3D heritage replication. Factum Arte's 1:1 scale replica of Tutankhamen's Tomb, installed in Luxor near the original (Figure 4) in 2014 (Factum Foundation 2016b), highlights some of the ethical problems that can arise from well-intentioned and highly accurate reproductions. The project was initiated in 2009 with the support of the Egyptian authorities, the University of Basel, and the Friends of the Royal Tombs of Egypt organisation (Factum Foundation 2016d). It was completed in 2011, but conflict in Egypt delayed the installation for three years (Factum Foundation 2016b & 2016d). While the project has since been expanded to include replications of other tombs nearby (Factum Foundation 2016f), the initial focus on Tutankhamen's Tomb was triggered by a growing consensus that it would need to be closed permanently in the near future: temperature and humidity variations caused by large groups of visitors, as well as high levels of atmospheric dust, air-borne pollutants and micro-organisms generated by the tomb's daily exposure, have led to the worrying separation of the plaster from the tomb surface (Factum Foundation 2016f).



Figure 4. The original Tomb of Tutankhamen, Egypt, 2007. (Source: Nasser Nouri, Flickr Creative Commons 2.0).

The existing global profile of Tutankhamen's Tomb may explain some of the publicity that Factum Arte's replica attracted when it was announced and then installed. Commentators have noted that the original Tomb will remain open for the foreseeable future, albeit with short visiting times enforced, while the highly-detailed replica nearby charges a lower admission and allows visitors to spend much longer in the Tomb space (Kingsley 2013, p. 23; Aspden 2014). This raises an interesting question for tourists: enter the 'real' tomb, but in doing so be a contributing factor in its decline? Or visit the 'fake' tomb, a replica that some have suggested is so convincing people may not be able to discern its 'real' age (Aspden 2014; Burrell 2014, 14)? What is most powerful about this situation

is that the moral decision on preservation rests with the tourists themselves—the replica tomb thereby forces a very personal confrontation with the broader conservation dilemmas commonly faced by heritage authorities and governments.

Another curious aspect of this situation is that the replica represents the Tomb as it was in 2009—a very different state to that on its discovery in 1922. Doubtless it will also wear and evolve differently to the original, and we must therefore consider whether its existence might inadvertently change or skew people's perceptions of the 'real' Tomb over time. Indeed, it seems unlikely that such replicas will be allowed to age at all. Instead, they can be more aggressively cleaned and repaired than any original, effectively freezing the experience of the artefact in time. A further concern in the case of the replica of Tutankhamen's Tomb is whether there is any need, or desire, to maintain conservation and repairs to the original once it closes to visitors. Without wanting to detract from the highly effective and undoubtedly useful replica created by Factum Arte, it nevertheless occasions the discussion of a potential flaw in the rhetoric of digital heritage practice: the very act of documenting and replicating, carried out in the name of heritage protection, may one day provide the excuse needed for some governments and authorities to neglect the original artefact. Worse still, for other sites, a digital backup may itself be deemed an adequate substitute that permits passive or wilful destruction of cultural objects that are expensive or simply inconvenient to maintain.

Discussion and conclusion

As 3D heritage replication progresses and its use inevitably grows, we must be mindful that it has the potential to instigate a wide range of problems, some of which are new to the heritage sector, and others that are new iterations of old or ongoing debates. In this discussion, attention has been drawn to just a few of the most pressing issues: the need to regulate digital heritage replication practices; the risk that heritage replications might be poorly executed or

used for ulterior motives; and the potentially negative consequences that even the most well-meaning and high-quality digital replication projects might incur. Some of these challenges will undoubtedly be addressed by the digital heritage sector in the short- and medium-term, while others may be harder to resolve.

Additionally, the paper has argued that over the technology's short history, the general public has been encouraged to see it as a sophisticated solution to an otherwise dangerous or costly problem. This attitude has been reinforced by magnanimous yet vague rhetoric expressed by industry leaders and organisations (doubtless with good intentions) and has been further hyped by simplistic or sensationalised press coverage. These are not processes that can 'save' or 'protect' built heritage, in any of the most basic senses of these words. While it is tempting to dismiss this as pedantry, when the press reports that digital heritage technology will 'save Syria's history from ISIS' (Greenberg 2015), facilitate Palmyra's 'rise' or 'rebuilding' from the rubble (Coghlan 2016; Jenkins 2016, 31), or 'defeat the wreckers' who engage in heritage terrorism (Macintyre 2016), it is arguable that a large portion of the public, as well as those in government making decisions on heritage matters, will take such claims at face value. In reality, digital technology can record, store and help us to interpret massive amounts of data, and we can use this data to make reproductions or inform decisions about conservation. This technology will not prevent vandalism or destruction, however, nor can it halt climate change or dissuade tourists who desperately want to experience the real thing. A 3D scan or physical replica, no matter how detailed, is not the same as—nor is it equivalent or adequate to—the heritage site or structure that it represents, and it is misleading to encourage a belief to the contrary. It is also deceptive, therefore, to foster a sense of boundless optimism and confidence in the existing systems, as this may only lead to complacency, adding to the risk of neglect faced by so much of our built heritage.

This technology is also in its infancy and, while it is making great leaps and bounds, many aspects of its practice still need development. It is not unreasonable, therefore, to suggest that an industry-wide convention or regulatory body is necessary to oversee, standardise and stabilise the booming digital heritage sector. An added level of governance may also address the need for more caution and transparency. The *Venice Charter* (1964) has proven inadequate to address the nuances of digital heritage practice, and the scope of the *Nara Document on Authenticity* (1994) is broad to the point of ambiguity. The *London Charter for the Computer-Based Visualisation of Cultural Heritage* (Version 2.1; London Charter 2009) may offer some provisions but does not fully encompass physical replication. These instruments of international heritage rely on governments and heritage agencies to ratify and enforce their content at the national level and, even then, they only operate as ‘best practice’ guidelines rather than legally-binding acts. In this vacuum, it falls to heritage practitioners, digital technology professionals and academics to engage in critical, theoretical dialogue that can inform global standards.

In a similar light, it is important that the efforts of organisations like IDA and Factum Arte be recognised and encouraged, as it is through such pioneering projects and experimentation that our understanding of the challenges and limitations of digital heritage technology and its application can strengthen and grow. Indeed, in order to answer many of the questions posed in this paper, it will be necessary for more of these types of projects to take place, for mistakes to be made, and errors addressed. Certainly, the expansion of the digital heritage sector needs to be accepted and supported by policy writers and academics, and, in return, the industry needs to acknowledge the long-term benefits to be gained from open engagement with critical issues such as those identified here.

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