British Art Studies

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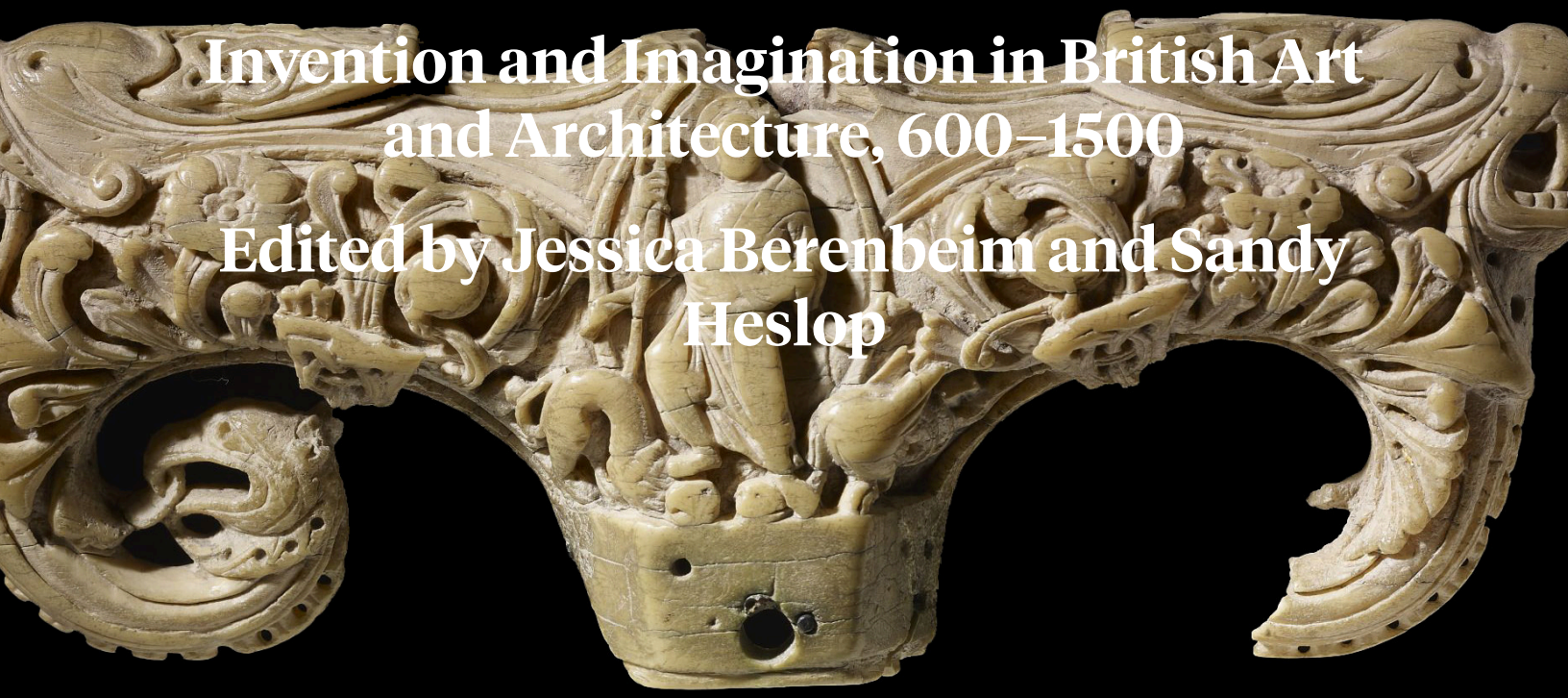
Invention and Imagination in British Art and Architecture, 600–1500

Edited by Jessica Berenbeim and Sandy Heslop



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Cover image: Unknown maker, Ivory Staff Terminal from Alcester, 11th Century, ivory, 14 × 5 cm. Collection of the British Museum (1903,0323.1).. Digital image courtesy of Trustees of the British Museum

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Disciplining the Digital: Virtual 3D Reproduction, Pilgrim Badges, and the Stuff of Art History

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Introduction by

Amy Jeffs, PhD Candidate, University of Cambridge

As part of a larger effort at the British Museum to 3D-model artefacts, the first phase of the Digital Pilgrim Project has applied this technology to medieval badges. In Europe, the large-scale copying of artworks began with die-stamped or cast metalwork. One such reproducible object took the form of the image-bearing pilgrim badge. Badges cast from moulds between the late thirteenth and early sixteenth centuries probably numbered in the millions, and were sold near cult sites to droves of pilgrims. [1] The fifteenth-century poet Beryn describes devotees of Becket visiting the badge vendors' stall upon leaving Canterbury Cathedral:

> Then, as manere and custom is, signes there they boughte,
> For men of contre shuld know whom they had soughte.
> Ech man set his sylver in such thing as they liked. [2]

Worn on itinerant, moving bodies to proclaim the pilgrim's special relationship with a patron saint, these souvenirs functioned as the mass media of the Middle Ages, inviting parallels with today's reproductive technologies. They often replicated iconographies and ornamental motifs current in contemporary deluxe manuscripts, monumental artworks, and architecture. To produce them cheaply, *en masse* and at speed, makers used eutectic lead-tin alloys that can be cast thinly at a remarkably low melting point (below 200 degrees centigrade) (fig. 1). The delicate, silver-bright objects that resulted from this casting technique reveal their base metal properties only with age. Together with secular badges, the numerous surviving examples in modern collections offer a fascinating overview of the vernacular visual language of medieval Christendom.

Watch Video

Figure 1.
Casting a Medieval Pilgrim Badge, Pewterer Colin Torode (Lionheart Replicas) casts a replica of a Thomas Becket Pilgrim Souvenir in the collection of the British Museum. Digital image courtesy of Digital Pilgrim Project.

The British Museum has over 680 medieval badges, nearly all of which were excavated in the last two centuries from the banks of the Thames. Five are on public display but the remainder are in storage. The former receive little attention from visitors and it is no wonder; time has robbed them of their sheen and obscured their imagery. Whatever appeal they might have had as tactile souvenirs is denied the modern viewer by the need to preserve them behind glass. The Museum of London, with its more local historical focus, has a considerable number of medieval badges on display, pinned so that visitors can see both sides, but there are still many hundreds more in store. Their mobility and sheer proliferation are central to their interest as a source. Nevertheless, these two features resist communication in the usual display contexts.

For art historians, medieval badges represent an artistic source found archaeologically in great number, connected to the most artistically active institutions of the period and worn publicly by individuals from a range of socio-economic backgrounds. They thus have much to tell us about the movement of images in geographical and social terms. As we digitize collections for online catalogues, providing auxiliary platforms for

visualizations in digital media offers a means of highlighting the research potential of the object type, a stand-alone research tool, and a point of access to facilitate further study.

The project aims to use the medium of 3D modelling via the Sketchfab interface to address the challenge of communicating tactility.[3] The resulting sample of twelve 3D models allows online visitors to select and virtually handle objects. The image is augmented with interactive annotations, which expand when selected to offer explanations of iconography, manufacture, and use. The labels are unobtrusive so that the reproduction dominates the viewing field. This 3D technology allows the historically overlooked object to be celebrated with unprecedented emphasis on its aesthetic qualities.

The growing ease and popularity of applying digital media, such as 3D modelling, to art-historical causes raises questions for the field. What do such technologies offer to the practice of art history in museums and universities? What dangers might be associated with our increasing reliance upon them? This British Art Studies “Conversation” feature brings together specialists associated with pioneering digitization projects to assess four strands of enquiry: how to qualify experience, how digital tools can dramatize display, the utility of 3D modelling as a research tool, and the subsequent status of the original in relation to the reproduction.

Accessibility and Experience

There are many advantages to working with digital media for an art history project. The sheer novelty of the digital can attract attention to understudied original objects, in this case, medieval badges. Since being uploaded between July 2016 and January 2017, the Digital Pilgrim models have received over 5,200 views on Sketchfab. At a scholarly level, they are already being cited in major publications, used for university-level teaching, and informing dissertations. These successes prove the value of virtual handling, and affirm the ease of accessibility and the discoverability of the British Museum’s page on the Sketchfab platform.

Our 3D model of the “Herte” badge received over 730 views in nine months (fig. 2). In reality, it is in storage and has been out of public view since 1848. Taking into account its historical neglect and lack of reputation, these viewing numbers are a coup for an impact report and show a great improvement on its availability heretofore. Yet questions arise that are hard to overlook. For one thing, is the convenience of the digital 3D model detrimental to the quality of the viewer’s experience? The lovers’ token presumably symbolized an intense emotional experience for at least one person. Likewise, in order to purchase a pilgrim souvenir, the medieval individual generally had to undertake a long, expensive, and possibly

dangerous journey. The profound sentimental value assigned to these objects by their footsore owners is attested by the surviving hoods and manuscript pages neatly decorated with personal collections of pilgrim badges.

View this illustration online

Figure 2.
Herte badge, ca. 14th–15th Century, lead alloy, 4.6 x 3.3 cm. Digital replica of pilgrim souvenir in the collection of the British Museum (1848,0828.7). Digital image courtesy of Model created by Rob Kaleta for the Digital Pilgrim Project (2016). Taken courtesy of the Trustees of the British Museum.

In contrast, digital technologies, including the 3D model, go hand in hand with the values of convenience and speed that characterize the internet age. Once we have capitalized on the medium's assets and successfully invited viewers to the model, is there any call for further intellectual and emotional investment in the experience? *For the first wave of this provocation, respondents are invited to explore whether digital reproduction can provide meaningful encounters with original objects and, if so, how can that be measured?*

Public Engagement

3D modelling is being enthusiastically utilized by museums to increase opportunities for public engagement. When we uploaded the first of the Digital Pilgrim models in January 2016, there were only sixty-five models on the British Museum's Sketchfab page, mostly representing larger sculptural objects in the museum's collection. Now, that number has increased by over one hundred, includes more miniature pieces, and continues to grow. The self-evident archival benefit is that 3D models create an accurate record of objects in collections. However, there is also an important interpretative benefit. Prior to the digitization project, there were few opportunities to provide additional resources to complement the five badges on display, as well as for interpreting the rest of the collection in storage. In the gallery space, the small, grey objects are easily overlooked. This vast collection of miniature sculptural artefacts was calling out for a resource that could isolate and celebrate individual pieces, as well as contextualizing their place within collections.

The curators of the medieval Europe collections, Lloyd de Beer and Naomi Speakman, had already been experimenting with 3D modelling, so we applied it to medieval badges in earnest. The Sketchfab platform bridges the gap between the online catalogue and the gallery, enabling the interpretation of objects in new ways. Pilgrim badges, which are suited to being held and turned in the hand, have not only been afforded new

visibility, but, in addition, the virtual handling offered by the 3D model, designed to enable turning and zooming, reflects authentic modes of interaction with the object.

The digital 3D model complements conventional museum displays and simulates direct encounters. Clearly, the technology is particularly suited to some object types, such as miniatures and artworks that were intended to be held and turned—experiences that are inaccessible to us in the present. *This corpus is being more clearly defined with every new model posted online by cultural heritage institutions. The second wave of respondents will address how museums and galleries might make most effective use of digital 3D modelling.*

Utility for Teaching and Research

A digital 3D model holds spatial information, marking a significant deviation from its static 2D predecessors. It is essentially a code that records scale, texture, and colour in minute detail, building point clouds from hundreds of photographs, connecting them up with a mesh before imposing surface texture and colour. [4] On Sketchfab, this is conveyed on the screen using linear perspective, creating an illusionistic sense of pictorial recession as the image is manipulated by the viewer. It is an accessible, detailed and interactive means of representation that serves art-historical research by providing accurate data and stimulating new perspectives.

There are many other objects in museum storage that could be similarly interpreted, bringing long-hidden resources to students and allowing young scholars to engage in primary research early in their careers. Nevertheless, art historians have only relatively recently begun to realize the utility of 3D modelling; for some, the demands of research questions lead serendipitously to the technology, for others, knowledge of the technology provokes new questions. *The Zurich Declaration on Digital Art History* states that “there should be a productive two-way relationship between research questions and digital applications.” [5] However, as and when applications are discovered, it is crucial they are shared, and that art historians are generous in outlining their methodologies for the benefit of the discipline. This Conversation piece hopes to provide a forum for projects employing 3D digital technologies to share their applications of the medium to art-historical ends. *The third element of this provocation is an appeal for examples of whether, how, and why 3D modelling has proven an effective research tool.*

Honouring the Original

Finally, do advances in digital imaging technology threaten a loss of interest in the original? The latest waves of the so-called “material turn” have ushered in object-focused extra-curricular courses for doctoral students that are becoming commonplace for humanities programmes in higher education institutions. [6] On the one hand, the digital 3D model may seem at odds with the movement: yet another form of replication diluting the status of the original. On the other, I would argue that, particularly for inaccessible artworks, modelling bridges the gap between viewer and artefact more successfully than traditional modes of reproduction, generating an imaginative encounter by intensifying some sensory information and muting others.

The digital 3D model is currently the most accessible, democratic mode of reproduction available as a surrogate for a direct encounter. *My final question asks what 3D modelling offers our experience of the original.*

Conclusion

3D digital media can be used to generate aesthetically rich reproductions of artworks that are novel, accessible, and infinitely shareable. Their digital platforms preserve information quantifying interactions that are a great help in measuring the “impact” of a project. Despite these benefits, there remains no truly effective automated tool for measuring depth of experience; assessing the human response still depends on processes like conversation and written testimonial, albeit accelerated by feedback forms, email, and comments posted online. These subjective and partial modes of evaluation augment newer metrics and have the power to prompt further enquiry, as befits our work in the Humanities. They demand that we interrogate our perceptions of what constitutes an aesthetic encounter—as explored in the response to this piece by Erich Hatala Matthes—and, as Fern Insh argues, discover how the utility and popularity of digital visualizations may help safeguard the future of art history.

Thomas Flynn’s response demonstrates that in the case of fragile or inaccessible objects, our ability to offer informative and aesthetically compelling surrogates for the direct encounter facilitates important public engagement with heritage objects. Nevertheless, Dan Pett warns against over-emphasis on the popularity of 3D media, offering a broad view on public engagement and citing politically controversial cases.

When it comes to teaching and research, the data capital of the 3D model is unsurpassed. The fact that models can be projected into lecture theatres, where they can be manipulated by the speaker and later viewed from home

at the student’s leisure, is already enriching university teaching (as Lucy Splarn attests). Moreover, the medium of 3D visualization itself allows for unprecedented virtual close-looking and contains valuable spatial information that can be applied to research questions, such as those raised by Sofia Gans in relation to the periodization of bronze casting. Likewise, as Tim Ayers’s example of the “St Stephen's Chapel, Westminster: Visual and Political Culture, 1292–1941” demonstrates, scholarly involvement in digital reconstruction demands academically productive imaginative recreation of the original making process, extrapolated from the scant remains of the source in question.

The final responses explore the potential for 3D reproduction to lead to some kind of loss of the original. Robert Hawkins shows the advantages of the 3D model over the static, planar medium of photography for the study of sculpture, while Gabriel Byng considers how various forms of reproduction may aid the interpretation of an obscure original. And yet, despite acknowledging the power and potency of digital replication, Tom Nickson argues for the fundamental irreplaceability of a direct encounter with the original.

This Conversation brings together a polyphony of voices, drawn from a range of positions in the small but growing world of digital art history. Similarly, possessing a plurality of reproductions that oribit the designated original is like peering through a selection of lenses. Together, they bring in and out of focus the various meanings of the object of study and enhance its presentation to a broad and complex array of audiences.

Response by

Fern Insh, Andrew Mellon Digital Research Forum Project Officer, Courtauld Institute of Art

#DAHRG and Rethinking Art History

Reflecting on my first year as The Courtauld's Digital Research Forum Project Officer, I am particularly proud of creating #DAHRG. The hash-tagged battle call, short for Digital Art History Research Group, invites researchers to take a small, combative step towards changing how art history is published, studied and taught.

I began my career as a conventionally trained art historian. My PhD and immediate outputs analysed the reach of the location of images in post-Reformation Scottish society. The potential impact of the research was only realized when I undertook a postdoctoral role that required me to build a tourism app (Discover: Old Aberdeen). After creating digital models for inclusion in this app, including an image of pre-Reformation St Machar's Cathedral (fig. 3), I realized that my academic knowledge and technological skills were allowing me to represent virtually the lost fabric of pre-Reformation Scotland. After the app's release, app users and staff from other departments and institutions took an interest in my research. I am positive this reception was down to digital models having the ability to captivate and inspire. It was from this learning that #DAHRG was formed. I believe that digital skills, skills that bring research to life, should be mandatory for art historians.

Watch Video

Figure 3.
St Machar's Cathedral prior to the Reformation, 2016, digital model. Digital image courtesy of Fern Insh.

#DAHRG hosts seminars on inspiring projects and runs digital technology workshops. For example, a CAD for Architectural History workshop, led by Meg Bernstein and myself, taught basic SketchUp skills (CAD stands for Computer-Aided-Design). Likewise, Digital Pilgrim's Rob Kaleta led a session on how to make 3D models of small artefacts using the Structure-from-Motion technique (SfM). The impressive "impact" statistics of Digital Pilgrim show how an early career art historian might benefit from learning the labour-intensive, yet not unfathomable, skill of SfM. [7] The purpose of #DAHRG's maiden year, therefore, has been to teach participants how to use digital technologies to enhance both research methods and scholarly impact. For the second year of #DAHRG I intend to organize intensive, research-focused workshops. Future CAD workshop participants, for instance, will learn to demonstrate the value of their work in a visually stimulating, accessible way.

To remain current, the traditional presentation and study of art history needs upgrading. Increasingly, our intended audiences access information from mobile sites and apps on phones and tablets. If art historians are not making research outputs compatible with such platforms, then they will miss reaching audiences that may care about their research. #DAHRG, therefore, simply teaches skills needed today to communicate art-historical research

effectively and, additionally, encourages art historians to not exclude “digital” in their self-definition. Ultimately, I hope that this action will provoke a cultural change and that art history tutorials will begin looking more like #DAHRG workshops (fig. 4). If we, the wider scholarly community, do not adopt a unified digital strategy, then we will lose the ability to inspire the public and, by extension, a future generation of art historians. Without inspiring this audience, we can anticipate more funding cuts and further departmental liquidations. In short, by making art history digital now, we can save its future.

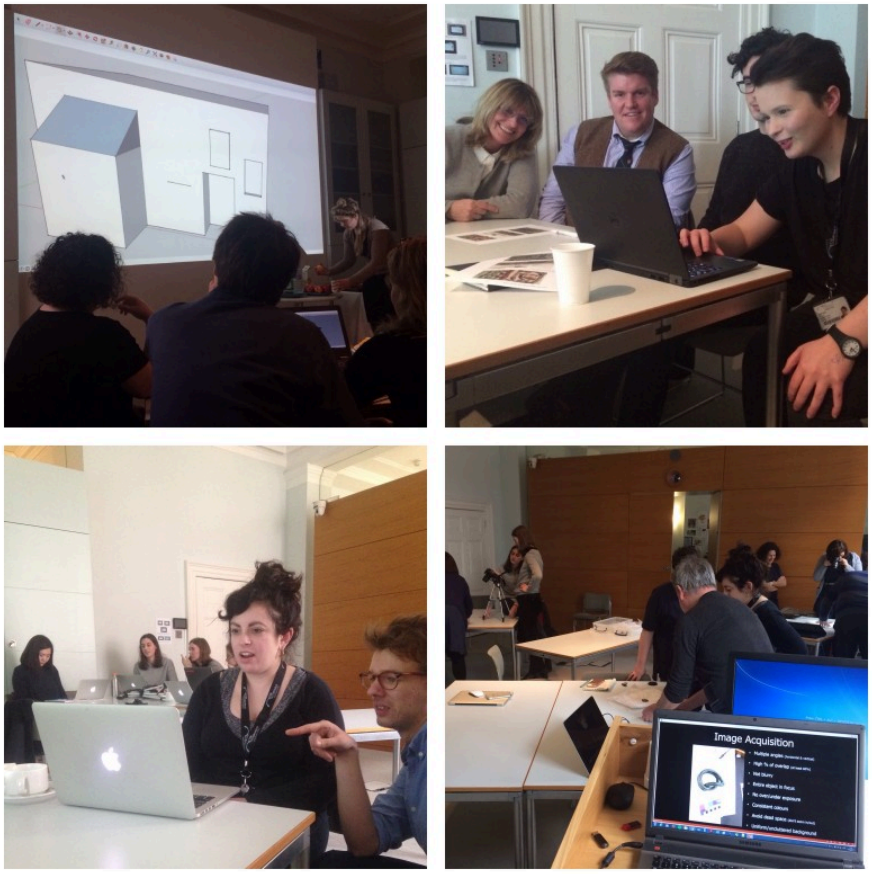

Figure 4.
1 #DAHRG workshops in action, 2017. Digital image courtesy of Fern Insh.

Response by

Erich Hatala Matthes, Assistant Professor of Philosophy, Wellesley College, Massachusetts

The Experience of Digital Models

How should we qualify the experience of a digital 3D model? Is it akin to the experience of a cheap and convenient knock-off that undermines the value of authenticity? Or might it offer a rich new avenue for the experience of art and history? I wish to offer two brief considerations in support of the latter conclusion.

Among the kinds of experiences offered by art and artefacts are *aesthetic* ones. In contrast with the formalism of the mid-twentieth century, which construed aesthetic experience exclusively in terms of the perceivable properties of the object, many philosophers today think of aesthetic experience as being strongly conditioned by a range of mental capacities. As Alan Goldman puts it, aesthetic experience is "imbued with thought, imagination, and emotion". [8] So, first, 3D models offer the promise of engaging our intellectual and imaginative faculties in ways that are often precluded in a museum context, particularly for the public at large. For instance, the ability to manipulate a 3D model can reveal spatial relationships and details that a photograph might obscure. The addition of annotations, sounds, and other sensory components can likewise offer new perspectives on dormant or underexplored objects.

Some critics raise concerns about how replicas might diminish aesthetic experience. Carolyn Korsmeyer has emphasized how "implicit touch" or mere proximity to genuine items, as opposed to replicas, can facilitate a transitive connection with the past: you are in the presence of an object that itself bears the touch of an historical figure, that itself existed in a prior time. [9] She worries that replicas, made from new material or existing in the digital realm, sever that connection. However, although 3D models are a step removed from originals, the intimate relationship to the original in the production of a high quality model (capturing every contour and crevice through scanning and photography) is like a digital caress that might plausibly preserve the very transitive relationship to the past that Korsmeyer is concerned with. 3D models also offer an engaged kind of "touch" through manipulation of the model that could be more generative for aesthetic and educational experience than mere proximity to an encased original.

Second, the quality of the experience of 3D models must be weighed against the lack of public access to substantial portions of museum collections. As Joseph Raz writes: "the point of values is realized when it is possible to

appreciate them, and when it is possible to relate to objects of value in ways appropriate to their value. Absent that possibility, the objects may exist, and they may be of value, but there is not much point to that." [10] 3D models help prevent cloistered collections from being valuable but unappreciated. This is, of course, not to claim that the original becomes dispensable once a model is available: as I have suggested elsewhere, digital replicas could very well increase interest in the original, especially where it is otherwise unknown or inaccessible. Such interest could prompt renewed visits to neglected collections or reshuffling of curated displays that would otherwise have been unlikely to occur.

Thus, we have reason to think that 3D models can both offer unique and valuable modes of aesthetic, material, and experiential engagement, as well as offering the promise of renewed public and scholarly interest in otherwise inaccessible originals. They provide a stimulating complement that can work in concert with, rather than replace or diminish, original collections.

Response by

Tom Flynn, Cultural Heritage Lead at sketchfab.com

3D modelling for Public Engagement

When a direct encounter with an historic artefact is impossible, 3D models allow people to explore an object beyond either the static images of the online catalogue or the fixed view of the original behind glass. The 3D model allows rotating and zooming to discover true shape and detail. Indeed, some details, such as the specular shine of gold lettering on the reverse of these nineteenth-century "cabinet cards" are especially well suited to viewing in 3D, where the viewer can observe the play of light (in this case artificial) across an object's surface. 3D modelling has many applications, some of which I will present here, that are quietly redefining the relationship between the public and museums.

The provocation specifically considers the 3D modelling of objects that are held in museum stores, but the technology can also be applied to objects beyond the museum. As repositories of human experience, museums can benefit from 3D modelling's potential to record ephemeral or immovable objects with unprecedented precision and to bring them into the institutional space (whether real or virtual). Equally, these tools might be used to foster relationships with the architecture and land art of remote or unstable regions, as well as archaeological and natural sites.

It is important to emphasize that 3D modelling need not mean that the original is ignored. A revolutionary aspect of 3D modelling is that members of the public can be involved in the making of reproductions. With little training, they are already helping to contribute to the massive task of 3D digitization at the photography and image preparation stages. For example this is how a local community group helped create models for the British Museum's Object Journeys project. The Micropasts project has also shown that volunteers across the world are willing to contribute to other parts of the photogrammetry workflow.

Virtual technologies can aid the contextualization of originals. The data from the 3D reproduction can be used to create virtual reality (VR) and augmented reality (AR) experiences that help communicate the meaning of historical objects. With minimal setup, all models uploaded to Sketchfab can be viewed in VR on desktops and smartphones. As content production for these technologies is still young, the field is wide open for experimentation.

In fact, 3D modelling can be used to generate a wealth of experiences, whether real or virtual. 3D files can be downloaded and printed, thereby taking on a third existence. Not only does this bring the public closer to artefacts in a very personal way, but it is also allowing people whose primary means of experiencing the world is through touch rather than sight to learn by feeling the form of an artefact. Some people have even brought their own 3D prints to meet the original at the museum. 3D data can complement a variety of resources and help to dramatize collections. By combining it with images, audio, and text it is possible to create rich sensory experiences. Museum in a Box is just one of the initiatives seeking to leverage the value of 3D in combination with other media for the benefit of education within the cultural heritage field.

Finally, the experiences of operators of virtual material are as real as those of any visitor to the museum gallery. As people spend more time browsing online, 3D digitization offers a chance for historic content to reach new audiences. 3D models from the British Museum have been featured on specifically “tech” oriented sites like Gizmodo and Techcrunch. Likewise, the community on the Sketchfab platform itself is diverse, including video game artists, scientific researchers, VR enthusiasts, and engineers. By publishing to Sketchfab, which has averaged twenty million visitors per year in five years, the British Museum is able to reach audiences that may not be among the seven million visitors per annum to its galleries.

It is probably worth noting at this point that 3D modelling cannot do everything we would hope at the moment. Photogrammetry is an accessible method of digitization but it has its limits—it’s extremely difficult to scan very shiny objects and near impossible to get results from images of transparent or translucent subjects. Additionally, there is still a huge amount of work to be done in regards to formalizing 3D modelling within the wider context of museum work: acceptable levels of precision; universal scale and colour standards; how best to archive 3D files and in what formats for future use; the ethics involved in the scanning and display of some subjects; linking 3D data on platforms like Sketchfab to the masses of metadata generated; how to display often huge 3D datasets on the widest variety of devices. Organizations like the Wellcome Trust and Collections Trust, the Rijksmuseum, the IPERION CH, and the CNRS are tackling these issues by hosting conversations and research in this area.

It is only through testing the opportunities and limits of 3D modelling that we might come to understand its true potential for engaging the public in meaningful ways with historic collections. 3D modelling is simply a next step in visualization, but the possibilities of the medium for public engagement (along with its re-use online and in VR, AR, MR, and physical experiences) are

excitingly unknown. It is only in the last few years that increased access to digitization and publishing platforms has enabled large-scale creative exploration of the medium.

As the efficacy of these experiences is tested by audiences and academics alike, the focus is moving swiftly from an interest in the technology of 3D digitization to the best practices and formats for education, engagement, and storytelling.

Response by

Daniel Pett, Digital Humanities Lead, British Museum

"The concept of 'anyone' is key to the discussion of 3D production"

The burgeoning 3D scene provides a panoply of opportunities for academic and museum communities to engage with diverse and increasingly technologically astute audiences. Until recently, technological and financial barriers to entering the 3D realm have been relatively high, even insurmountable for private and public institutions and individuals considering the development of 3D models *en masse*. The advent of high-quality mobile phone cameras, mobile 3D production applications, and the rise of photogrammetry now makes it possible to cheaply and easily create 3D representations or even reproductions of suitable objects.

The concept of "anyone" is key to the discussion of 3D production; access to a camera and suitable software enables a wide range of participants to develop digital creations. Institutions have the choice to either get on board the 3D production line, or the public will come in and capture your sculptures, your objects and your three-dimensional spaces. The work of Sebastian Heath, Geoffrey Marchal, and Thomas Flynn, and the celebrated case of Nefertiti's bust by Nora Al-Badri and Jan Nikolai Nelles demonstrate how private individuals have acted independently of the institutions to which the artefacts belong. The public has also answered calls to collaborative community action, such as the crowdsourcing of Project Mosul

The British Museum's recent 3D productivity comes out of work by Thomas Flynn and the Arts and Humanities Research Council-funded MicroPasts project, which led to my colleagues and I trying to rapidly produce 3D content for public engagement. The Museum does not have an in-house dedicated 3D team and therefore capacity is limited. Ideally, knowledge transfer will happen amongst curatorial staff, with devolved responsibility for 3D documentation becoming the norm.

Models we have created have been used for the handling desks for blockbuster exhibitions such as *Sunken Cities*, for the innovative Museum in a Box project, for the work of the author of this provocation (Digital Pilgrim), for experimental archaeology, for PhD research on the morphology of palstaves, within Virtual Reality applications, for commercial product development, and most visibly within the British Museum's Room 3, and with high impact on the Sketchfab platform.

The move towards 3D as a didactic instrument can be demonstrated through photogrammetric models, such as the Skull whence British Museum curator Alexandra Fletcher used her expertise to annotate a model. This enabled it to be embedded in the National Geographic's story, transferring her encoded or visualized scholarship to a large audience. This model now takes on a public engagement aspect of its own; it can now easily be reused as a teaching tool. The model itself can also generate serendipitous re-use through integration with third-party applications such as VR environments (see the British Museum's Oculus demo), through home or office printing for use in educational environments, and through derived artistic reinterpretation.

However, we must not ignore the fact that statistics show these models are not used by mass audiences. A cursory glance at the Sketchfab platform shows that many 3D models garner several hundreds of views, but very few receive viewing figures in the thousands and even fewer in the millions. There are also notable examples of negative 3D public engagement: the Palmyra arch debacle is a prominent example of the mistaken belief, perpetrated by the popular press, that recording and documentation processes are equal to the preservation of original artefacts.

The future is positive for the ethical use of applied 3D technology, and the public is the key. The production of 3D data is now democratized, the ubiquitous mobile phone in your pocket allied with the power of cloud computing, allows everyone to create or even co-create high quality output. Whether the public wishes to consume them in their everyday activities is to be seen, but opportunities to push this consumption to mainstream audiences will increase annually.

Response by

Tim Ayers, Professor in the History of Art, University of York

For the recent AHRC-funded research project “St Stephen's Chapel, Westminster: Visual and Political Culture, 1292-1941”, we set out to visualize the interior of a great lost building. St Stephen’s served first as a medieval royal chapel, which we modelled as it might have looked in the 1360s (fig. 5). In 1547 it became the House of Commons, which we modelled as it might have looked in 1707. The growing potential for 3D modelling to visualize something *lost*, as much as to reveal the appearance of something hidden, was demonstrated by the resulting animation.

Watch Video

Figure 5.
St Stephen's Chapel, Westminster, virtual reconstruction, 2016. Digital image courtesy of St Stephen's Chapel Westminster Project 2017.

Virtual modelling was intended to help us address research questions: the character of these spaces in relation to liturgical and political practices, and relationships between them over time. It also allowed us to present project findings to the public. For both purposes, the medium poses a challenge, as models do not present an argument in and of themselves. To be of value for research purposes, they need to be integrated into the scholarly process, and fully documented. These issues are addressed by the London Charter which sets high standards for the computer-based visualization of cultural

heritage. Our decisions about developing the model were made on the basis of workshops with other scholars, and will be published shortly as a way to fulfil the Charter's requirements, but are also presented to some extent within the models themselves, among the interpretative tools.

I would identify three particular research benefits from the process, all involving the visual imagination. The first was the chance to experiment with possible forms for the building. Antiquaries, architects, and scholars have reconstructed St Stephen's often over the last two centuries, in a long tradition of recording architecture on paper. These records are sometimes contradictory. Furthermore, the upper parts of the building will never be fully known, as they were destroyed before any detailed record was made. We took the opportunity to explore alternatives, therefore, especially in height and structure.

Second, the decision to reconstruct furnished interiors allowed us to experiment with interior spaces. In the medieval model, we made a timber screen to divide the choir from the antechapel, a liturgical division, it has been argued, that shaped the political division of the commons chamber and its lobby. As a working hypothesis, we placed it at the lobby/chamber divide, and tried to fit it into a highly decorated space. In conversation with Hugh Harrison, a specialist in timber structures, we learned how it could be constructed, but also deconstructed, in frames. The screen is known only from documents but signalling its presence is important to understanding the history of the building.

Finally, the project forced us to bring together, in three dimensions, many kinds of materials that are often studied separately, from woodwork and stone sculpture, to stained glass and wall paintings, and to think about their interrelationships. These outputs depended on collaboration with many different scholars, which was revealing in itself. We cannot retrieve the interiors exactly, but we can approximate an experience of them, from the astonishing lavishness of the medieval chapel to the cramped conditions of the early modern House of Commons.

Here, "Experiment" is certainly the operative word. Both in terms of the building's form and its furnishings, our visualization can be neither "right", nor complete. This is an important qualification both for public engagement and scholarship, as virtual models with a level of finish can have an appearance of authenticity. For the researchers, however, the models forced us to confront and re-imagine the original creative process. How may the lost stained glass have been conceived to work with the liturgical layout, the surviving wall paintings, and the recorded sculpture? How could the medieval interior be adapted to seat members of parliament after 1547? In short, how may the opportunities and constraints of the commission, or the existing building, have informed the decisions that were made?

Response by

Sofia Gans, PhD Candidate, Columbia University

Photogrammetry as a Research Tool for Technical Art History

Indirect bronze casting is a technically complex process whereby multiple identical bronze figures are cast from a single initial model. [11] 3D modelling enabled me to prove that, contrary to current understanding, the technique was used in German-speaking lands just as early as in Italy, and perhaps even earlier. [12] The research formed part of my doctoral dissertation, which seeks to correct an imbalance in the study of bronze sculpture. Historically, the field has paid most attention to Italian casting techniques in the fifteenth and sixteenth centuries, while largely ignoring developments north of the Alps. I used the Vischer workshop of Nuremberg as a case study—a prolific family of founders active from 1453 to the 1540s—and employed 3D modelling, in particular photogrammetry, to show that this German workshop cast multiple bronze figures from the same few models. [13]

Several of the Vischers' tomb commissions contain cast brass figures that appear to come in pairs, with slight variations in pose and attributes (figs 6–9). To determine whether these sculptures had indeed been cast from the same model using indirect casting, I had to acquire precise measurements of these works and compare them, as sculptures cast from the same model would have identical measurements. Photogrammetry was the perfect tool for this, as the technique generates precisely scaled virtual 3D models from a set of photographs which can be compared against each other in a digital environment. [14] It is also better suited to objects that do not reside in museums than other methods of 3D capture such as laser scanning, as it is easier to obtain permission to capture non-invasive photographs on-site than to bring in laser scanning equipment.

Figure 6.
Vischer Workshop, Apostle, brass, Tomb of Archbishop Ernst of Saxony, circa 1495, Magdeburg Cathedral, Magdeburg, Germany. Digital image courtesy of Sofia Gans.

Figure 7.
Vischer Workshop, Apostle, brass, Tomb of Archbishop Ernst of Saxony, circa 1495, Magdeburg Cathedral, Magdeburg, Germany. Digital image courtesy of Sofia Gans.

Figure 8.
Vischer Workshop, Apostle, brass, Tomb of Archbishop Ernst of Saxony, circa 1495, Magdeburg Cathedral, Magdeburg, Germany. Digital image courtesy of Sofia Gans.

Figure 9.
Vischer Workshop, Apostle, brass, Tomb of Archbishop Ernst of Saxony, circa 1495, Magdeburg Cathedral, Magdeburg, Germany. Digital image courtesy of Sofia Gans.

In the fall of 2016 I photographed the figures on the tomb of Archbishop Ernst of Saxony in Magdeburg Cathedral, cast around 1495 (fig. 10). I included scale bars calibrated to .0001mm accuracy, which allowed me to scale the point clouds I generated using the program Agisoft Photoscan. [15] I compared these point clouds using the software CloudCompare, which registers the two point clouds against one another, then calculates the distance between them, providing the user with a depth-map of where the clouds differ (figs 11 and 12). All the models from the Magdeburg tomb were identical to within .0001mm, aside from the areas that had been purposefully modified in the wax intermediate model. For multiple sculptures to be so close to identical, the artists would have had to employ indirect casting. I

was therefore able to show that this technique was already in use at the Vischer workshop in the 1490s, without any documented exchange with Italian craftsmen.

Figure 10.
Vischer Workshop, Tomb of Archbishop Ernst of Saxony, circa 1495, Magdeburg Cathedral, Magdeburg, Germany. Digital image courtesy of Sofia Gans.

I employed 3D modelling to answer a quantifiable research question, proving that indirect casting had been in use in Germany at the same time, and perhaps even prior to its use in Italy. My conclusion doesn't simply make assumptions based on visual comparison, but rather provides verifiable, repeatable, data-centred proof. This was essential in order to change the long-standing accepted timeline of bronze casting innovations in western Europe, thereby further challenging art history's Italo-centric worldview, which presumes Italian artists of the fifteenth and sixteenth centuries were technically superior to their northern European contemporaries. Investing time and resources in learning the techniques of photogrammetry produced manifold research benefits. As well as serving my primary hypothesis, clarifying the casting techniques used by the Vischers opened up avenues to re-examine more traditional art-historical realms such as division of labour between artisans and workshops, training and apprenticeship, and city craft regulations. This in turn leads to a rich, interdisciplinary form of technical art history.

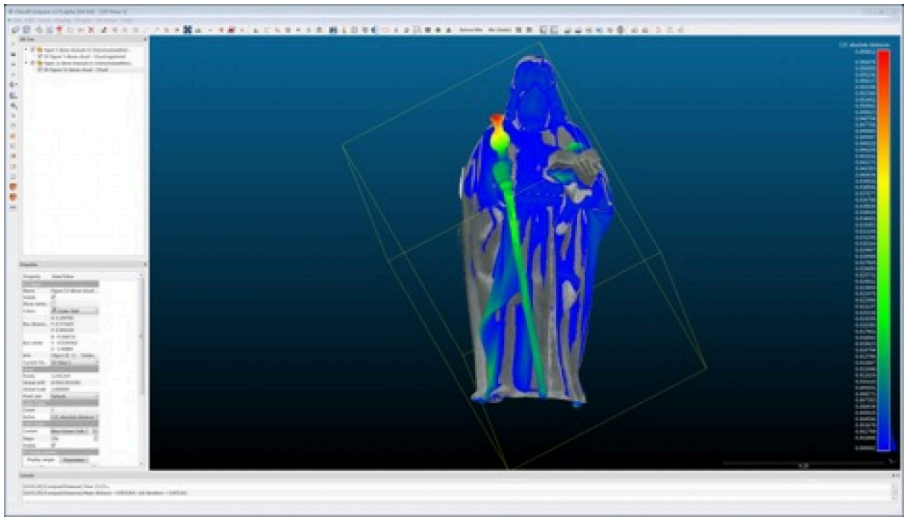

Figure 11.
Comparison of figures 6 and 7 in CloudCompare, Figure 6 is shown in native colors (colors sourced from the photographs), while Figure 7 is overlaid in a depth map. The scale to the right shows the meaning of each color in millimeters. The majority of blue sections indicates a difference of less than the accuracy of the models' scale, which is accurate to .0001mm. Digital image courtesy of Sofia Gans.

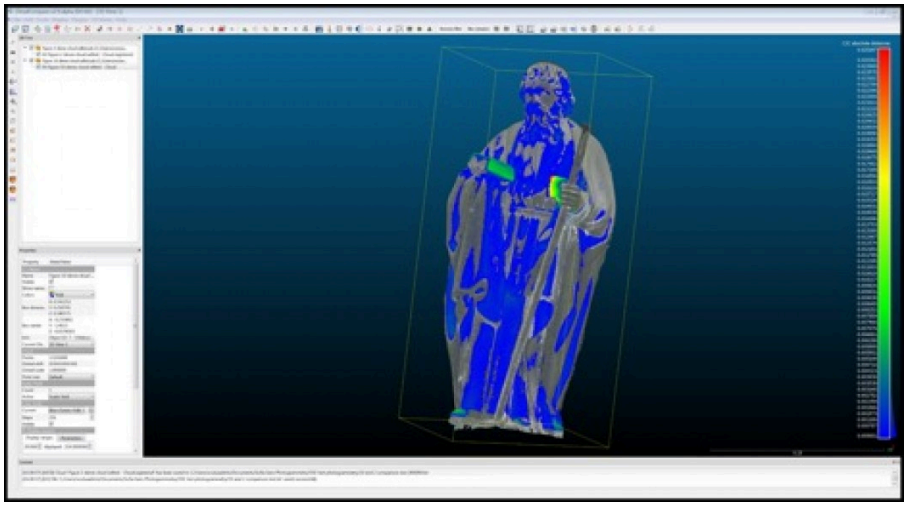

Figure 12.
Comparison of figures 8 and 9 in CloudCompare, Figure 8 is shown in native colors (colors sourced from the photographs), while Figure 9 is overlaid in a depth map. The scale to the right shows the meaning of each color in millimeters. The majority of blue sections indicates a difference of less than the accuracy of the models' scale, which is accurate to .0001mm. Digital image courtesy of Sofia Gans.

Response by

Lucy Splarn, Undergraduate Student, University of Kent

Working from 3D Models for Undergraduate Art History

My fellow BA students and I are conversant with and dependent on digital resources. We therefore welcome accessibility to innovative technological tools. For my final year dissertation, I wrote about the iconography and function of an original, almost entirely unstudied, pilgrim souvenir depicting Saint Thomas Becket riding a peacock. The sign depicts a figure in benediction perched on top of a hollow-based peacock with a frontal hook used to suspend a Canterbury bell. Whilst kept in storage at the British Museum, this special souvenir is evidently limited in accessibility, for it exclusively appears published in art historian Brian Spencer's pilgrim badges catalogue. [16] The object had been recently modelled in 3D by the Digital Pilgrim Project, and I found out about it via my course convenor, Dr Emily Guerry, in a module at the University of Kent that examined medieval saints, relics, and churches.

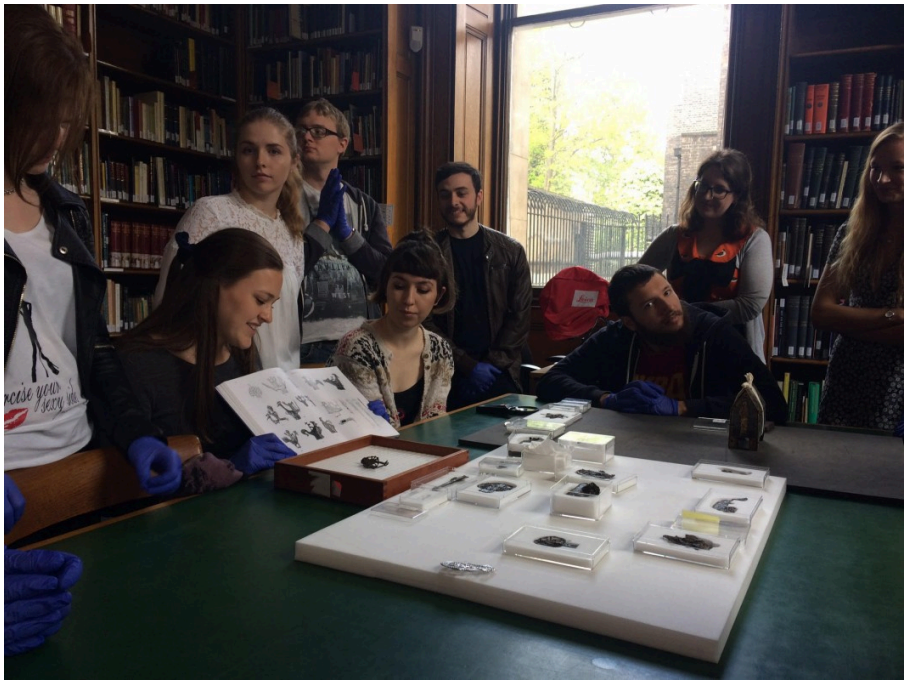

Figure 13.
Undergraduate Seminar, University of Kent. Digital image courtesy of Lucy Splarn.

The visual and tactile restrictions inevitable in gallery display and storage are in many ways overcome by Sketchfab. With a simple double click or swipe of the mouse, I could zoom in to the details of the souvenir and rotate it,

without losing any quality in pixel. This ensured my access to a high level of accuracy for a continuous and thorough examination. No other tool offered me such a unique opportunity to observe the object.

I did not meet the object face-to-face until a week before I was due to submit my dissertation. When it comes to getting a feel for the object, the proximity with which the Sketchfab experience matched my experience of holding the souvenir during a handling session at the British Museum demonstrates the advantages of the 3D tool over the standard two-dimensional printed image in catalogues. In fact, the digital tool played a major role in preparing my expectations of the Becket on a peacock souvenir prior to my first encounter with it. When I held the badge I could direct my focus on assessing the aesthetic expectations that I had already imagined based on the digital image. One obvious conflict arose between my expectation of its scale. The Sketchfab platform offers a “theatre mode” vision of the model which enlarges the image and, despite the clear dimensions that are included in the accompanying description, it had created an illusion that the badge was larger than its true form. However, at the same time, this feature enabled me to examine decorations in detail based on visually accurate evidence.

Fundamentally, the open-access online interface of the 3D model aided my opportunity to study an object that had received little to no attention from scholars and to do so at my convenience. As long as I had connection to the internet, visual analysis was possible from any location at any time of the day or night. Similarly, the “tag” tool connecting these tangible objects together through corresponding keywords was an effective method of which I took advantage, as it enabled me to compare and contrast the sign with other relevant material. It increased the efficiency in my research to compare the souvenir to similar artefacts.

Ultimately, in my experience, the digitization of pilgrim badges has the ability to break down the barriers that correlate with two-dimensional images and, in turn, generates an ideal perspective for foundational research in the technology driven mind of the contemporary student.

Response by

Tom Nickson, Lecturer, Courtauld Institute of Art

Ripped from the earth, smelted, transported, melted, and moulded. A brief moment of display on a hat or cloak before being lost or discarded. Preserved in mud, discovered, washed, catalogued, and, finally, stored. This is the life of most surviving pilgrim badges and ampullae. Whether drawn, photographed, or scanned, they lead more active lives on the page and especially the screen—clarified and magnified—than in the dark cupboards of the museum. Discussion of reproductions raises questions: is the original honoured this way? Should it be honoured? What is the original anyway: the badge or the mould into which it was poured or pressed?

3D reproduction offers exciting new ways to encounter these objects, but is something perhaps lost in translation? To be sure, the original badges have a weight and sense of proportion to the human hand that cannot be captured digitally. But we should not fetishize their tactility. Display in the gallery precludes touch just as much as the virtual model, and even those who have the privilege of handling such objects typically only experience texture through sweaty latex gloves.

Those who do need to see the original, or *might* need to see it, must second guess the curators who invariably act as gate-keepers, protecting “their” objects, as well as their own time. Why risk damage, when high-quality digital surrogates exist—surrogates that are far more accessible than the originals, and entirely adequate for most people? This is increasingly the policy of most collections, and rightly so. Manuscript scholars are already familiar with this problem, and in some cases resort to feigning interest in quire structure, evidence of use, treatment of the vellum, binding or other features in order to gain access. The problem is the “might”, for we cannot always anticipate the questions raised by direct contact with the original; experienced handlers can guess which questions might be relevant, but not new generations who are familiar only with digital surrogates.

Digital models themselves have an extraordinary power, which is why Digital Pilgrim is so effective. And such power is to be celebrated, but only provided we remain vigilant to de-contextualization. Digital models may be carefully explained and analysed on their original platform, but are vulnerable to copying, extraction, and insertion in new contexts where they lose their careful framing, like illustrations photocopied from a book. Moreover, for all that free sites such as Sketchfab seem to have a democratizing effect, juxtaposing objects from small and national collections and curating them in the same virtual space, the process of retrieving, scanning, and describing these objects still requires resources, so we must guard against reinforcing the gap between local and national collections.

There are other resource implications. Digital platforms soon become obsolete without maintenance, but this will only happen if given due emphasis by research funders. Extrapolation is another danger. The badges scanned for Digital Pilgrim are relatively self-contained, and anyway access to these originals will always be a problem. But we must beware of extrapolating from this, and infinitely diverting resources towards new technologies whilst cutting funding for study trips and other opportunities for encounters with (more accessible) originals.

For all their advantages, 3D technologies cannot yet capture the ever-changing, multi-sensory, and inspiring experience of visiting a great building or handling a miniature artwork: new technologies must enrich the original, not provide an excuse for forgetting it.

Response by

Robert Hawkins, PhD Candidate, University of Cambridge

Imaging Sculpture

> The picture can represent every reality whose form it has. The spatial picture, everything spatial, the coloured, everything coloured, etc. [17]

It is clear that photogrammetric modelling is an invaluable tool for replicating the spatial nature of the embodied experience of seeing. Unlike conventional photography it records the dimensions of an object in space, and can subsequently simulate the experience of a roaming viewer.

Since the early twentieth century it has been recognized that the photographs chosen to represent sculpture in publications have a great effect on the reader's (and author's) impression of the work. [18] And it is now evident that in a "feedback loop", the static image of sculpture offered by photography has dramatically influenced notions of "good" sculpture. Heinrich Wölfflin argued that any "good" sculpture should have one (or at most two) dominant angle(s) from which it ought to be viewed. His friend Adolf von Hildebrand demanded that sculptors produce plane-oriented sculpture to prevent the viewer from being restlessly "driven all around". [19] I would argue that this privileging of the plane, engendered and bolstered by the hegemony of the photograph, has severely compromised our understanding of pre-modern sculptural aesthetics.

Jacqueline Jung and Jules Lubbock, among others, have sought to challenge the dominance of single "authoritative" photographs in the discussion of sculptural monuments, instead offering sequences of photographs in their publications, in an attempt to represent for a reader the manifold viewing angles that some sculptures anticipate. [20] These photographic sequences, however, do not ultimately disrupt the hegemony of the camera: in presenting multiple viewpoints of sculptural objects, Jung and Lubbock challenge Wölfflin and Hildebrand's stress on a *single* plane—but still imply sculpture understood as a *succession* of planes.

Figure 14.
Roger Fenton, The Assyrian Gallery, British Museum, stereoscopic pair of photographs, circa 1850s.

Since the mid-nineteenth century, pioneers of photography have been aware, like Jung and Lubbock, of the limitations of the single, photographic plate. Innovators such as Roger Fenton and Charles Wheatstone sought to address these limitations, aiming to replicate more faithfully the experience of meeting a 3D sculpture in the flesh for the viewer at home (fig. 14). Their stereoscopic prints use two views of an object which, when viewed together, resolve in the brain to replicate binocular vision. Sculptural artefacts from the British Museum were, understandably, a popular subject for these early stereographers, just as they are today for makers of digital 3D models. In the late 1800s François Willème and Willy Selke realized the potential for a convincing 3D “surrogate” to emerge from the collation of a large number of static photographs, much like a modern 3D model. The greater the number of “planes” captured, the more accurate the replication of an object’s spatial character.

Photogrammetric modelling now encourages us to abandon “planocentricism” entirely, allowing a paradigm shift in our appreciation of the sculptural aesthetics of the past. Some major monuments have been largely ignored *precisely because* they beg for the viewer to be “driven all around” in the process of viewing. The fifteenth-century sculptural bosses of Norwich Cathedral cloister (the current focus of my PhD research) defy proper appreciation from any single, fixed viewpoint. Their hemispherical surfaces demand that the viewer move in iterative orbits, compiling an image of the whole scene in the mind’s eye. Photogrammetric models allow me to communicate the complexity of their spatial devices to a reader: to pass on the experience of roving around them, slowly appreciating their complex forms.

View this illustration online

Figure 15.
Herod and Herodias carving, ca. 1420–30. Digital replica of decorative element in the cloister of Norwich Cathedral. Digital image courtesy of Model created by Robert Hawkins (2017).

Response by

Gabriel Byng, Research Fellow, Department of History, University of Cambridge, and co-convenor of the *Digital Pilgrim Project*

Reading the Original: Cherries, Bombs, and Badges

The availability of digital models sounds like the climax of an art historian's Baudrillardian nightmare—when the thing itself gathers dust in the cupboard and students deal only in simulacra, their faces lit by the glow of a computer screen. Nevertheless, I suspect that reports of the original's death are greatly exaggerated. There are many reasons I could cite: that digital publicity stimulates pilgrimages to the original; that models allow for close examinations that even magnifying glasses cannot provide; that small, hard-to-display objects can receive attention that would be impossible even if they were on show (which they're not). But I want to take a philosophical tack and concentrate on a different "turn", not material but Kantian.

It is a truism beloved of first-year philosophy students that we cannot know the world itself, only impressions of it. So, do you and I see the same work of art, does our sense data match up? Let us take a pilgrim badge recently scanned by Amy Jeffs's Digital Pilgrim project. At a glance, it seems to show a sack with Looney-Tunes-style bombs bursting out of a hole in its side.

It takes a certain amount of training in the practice of iconography (and a read through the model's annotations) to realize that the sack is an upside-down hood and the bombs, cherries. But, once enlightened, it is impossible to regain fully the first impression, to see the sack without knowledge of what it "really" is. Sense data is mediated by experience. Connotatively, interpretations spiral—the Marxist holds a commodity, the metallurgist a demonstration of lead manufacturing, the cultural historian an example of the endurance of superstitious practices.

The difference between a sack of bombs and a hood of cherries is a cultural competence rooted in socially and temporally specific conditions. At one extreme, we could adopt the post-structuralist claim that authors bring the words (or, rather, lead) and readers bring the meaning. You and I might hold the same badge, but neither of us accesses the *Ding an sich*, only what our competence allows, or compels, us to see. What is so special about seeing "the original", if I hold a sack and you hold a hood? *Pace* Barthes, Foucault, or Derrida, historians, of course, privilege some interpretations above others according to long-standing conventions about how objects are appropriately contextualized using written and visual sources: the badge has formal similarities to an illustration in the Luttrell Psalter, contemporaries used good luck charms, there was a popular culture of badge wearing, and so on.

What I want to suggest is that some interpretations, including ones privileged by these conventions, are facilitated through digital reproduction, not despite but *because* they exaggerate, omit, hide, or warp aspects of the original. Imagine a nineteenth-century antiquarian, familiar with the Luttrell Psalter, making a watercolour of the badge. If they painted a cloth hood with red berries it might provide a more insightful or historically evocative image than a strictly observational recording. Reproductions, manual or mechanical, can be revealing in ways that clarify conventionally legitimate interpretations: the detail of the cherries' stalks, the manufactured hem of the face hole, the still-intact pin on the reverse, all come into focus as I zoom in and out, toy with contrast levels, increase the brightness. Far from supplanting it, the copy, like the computer monitor, sheds new light on the original.

Footnotes

1 B. Spencer, *Pilgrim Souvenirs and Secular Badges* (London: Her Majesty's Stationery Office, 1998), 13.

2 Beryn, "The Canterbury Interlude", in *The Canterbury Tales: Fifteenth-Century Continuations and Additions*, ed. J. Bowers (Kalamazoo, MI: Medieval Institute Publications, 1992), chap. 5, ll.171–73.

3 The second phase of the Digital Pilgrim Project is creating GIS maps to help visualize their proliferation.

4 The Digital Pilgrim 3D models were made using a digital SLR camera and Structure from Motion (SfM) software.

5 See the statement entitled "Methodology" in https://www.gta.arch.ethz.ch/events/digital-art-history-challenges-and-prospects (accessed 16 May 2017).

6 Including such initiatives as the CHASE "Material Witness" course, or the University of Cambridge's CRASSH "Embodied Things" research group.

7 At the time of writing, the twelve models on Digital Pilgrim's Sketchfab page had collectively achieved 4,783 views: https://sketchfab.com/britishmuseum/collections/digital-pilgrim, accessed 30 April 2017.

8 Alan H. Goldman, "The Experiential Account of Aesthetic Value", *The Journal of Aesthetics and Art Criticism* 64, no. 3 (2006): 337.

9 Carolyn Korsmeyer, "Touch and the Experience of the Genuine", *British Journal of Aesthetics* 52, no. 4 (2012): 365–77.

10 Joseph Raz et al., *The Practice of Value*, The Berkeley Tanner Lectures (Oxford and New York: Clarendon Press, 2005), 27–28.

11 For a discussion of indirect casting and other methods, visit http://www.nga.gov/exhibitions/2011/antico/glossary.shtm.

12 Current scholarly consensus holds that Italians were the first to develop a technique for hollow indirect casting, whereby multiple objects are cast from a single model, since Antiquity. Richard E. Stone, in his seminal 1981 article, posits that the sculptor Antico originated the technique in question in his workshop in Mantua in the 1480s. See Richard E. Stone, "Antico and the Development of Bronze Casting in Italy at the End of the Quattrocento", *Metropolitan Museum Journal* 16 (1981): 87–116.

13 Photogrammetry makes measurements from photographs and is part of the process of 3D modelling.

14 I am grateful to Michelle Marincola and the staff of the 2016 Summer Institute for Technical Art History at the Institute of Fine Arts in New York City for introducing me to photogrammetry, to the staff of Cultural Heritage Imaging in San Francisco for teaching me how to employ it, and to Jennifer Brown and the staff of the Digital Science Center at Columbia University for allowing me access to a computer powerful enough to process my models.

15 To see the models generated by this project, visit https://sketchfab.com/SofiaGans/models.

16 Brian Spencer, *Pilgrim Souvenirs and Secular Badges* (Martlesham, Suffolk: Boydell & Brewer, 2010), 75.

17 Wittgenstein, *Tractatus,* 2.171

18 H. Wölfflin, "How One Should Photograph Sculpture", trans. G. Johnstone, *Art History* 36, no. 1 (February 2013): 53.

19 A. Hildebrand, *The Problem of Form in Painting and Sculpture* (New York: G. E. Stechert, 1907), 95.

20 J. Jung, "The Kinetics of Gothic Sculpture: Movement and Apprehension in the South Transept of Strasbourg Cathedral and the Chartreuse de Champmol in Dijon", in *Mobile Eyes: Peripatetisches Sehen in den Bildkulturen der Vormoderne*, ed. David Ganz and Stefan Neuner (Munich: Wilhelm Fink, 2013), 133–73; J. Lubbock, *Storytelling in Christian Art from Giotto to Donatello* (New Haven, CT: Yale University Press, 2006).

Bibliography

Beryn. “The Canterbury Interlude.” In *The Canterbury Tales: Fifteenth-Century Continuations and Additions*, ed. J. Bowers. Kalamazoo, MI: Medieval Institute Publications, 1992, chap. 5.

Goldman, Alan H. "The Experiential Account of Aesthetic Value." *The Journal of Aesthetics and Art Criticism* 64, no. 3 (2006): 333–42.

Hildebrand, A. *The Problem of Form in Painting and Sculpture*. New York: G. E. Stechert, 1907.

Jung, J. “The Kinetics of Gothic Sculpture: Movement and Apprehension in the South Transept of Strasbourg Cathedral and the Chartreuse de Champmol in Dijon.” In *Mobile Eyes: Peripatetisches Sehen in den Bildkulturen der Vormoderne*, ed. David Ganz and Stefan Neuner. Munich: Wilhelm Fink, 2013, 133–73.

Korsmeyer, Carolyn. "Touch and the Experience of the Genuine." *British Journal of Aesthetics* 52, no. 4 (2012): 365–77.

Lubbock, J. *Storytelling in Christian Art from Giotto to Donatello*. New Haven, CT: Yale University Press, 2006.

Raz, Joseph, et al., *The Practice of Value*. The Berkeley Tanner Lectures. Oxford and New York: Clarendon Press, 2005.

Schröter, J. *3D: History, Theory and Aesthetics of the Transplane Image*. London: Bloomsbury, 2014.

Spencer, Brian. *Pilgrim Souvenirs and Secular Badges*. London: Her Majesty’s Stationery Office, 1998.

Stone, Richard E. “Antico and the Development of Bronze Casting in Italy at the End of the Quattrocento.” *Metropolitan Museum Journal* 16 (1981): 87–116.

Wölfflin, H. “How One Should Photograph Sculpture.” Trans. G. Johnstone. *Art History* 36, no. 1 (February 2013): 52–71.

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