

Impact case study (REF3b)

<p>Institution: Birmingham City University</p>
<p>Unit of Assessment: 34 – Art and Design: History, Practice and Theory</p>
<p>Title of case study: Craft informed 3D printing and digital reconstruction of precious objects changing museum and heritage sector practice</p>
<p>1. Summary of the impact (indicative maximum 100 words)</p> <p>Research by the Jewellery Industry Innovation Centre (JIIC) has been influential in taking curation beyond normal museum practice. The work has led to the development of novel applications of digital scanning, CAD processes and rapid prototyping. These have enabled the creation of detailed replicas of damaged and deformed precious and fragile objects of cultural heritage. Coupled with the craft design expertise of the researchers these processes have shed new light on the techniques used to produce the original pieces. The handleable replicas that these processes generate are transforming the way museum curators are balancing the competing demands of preservation, restoration and interpretation of objects with those of public access to them. JIIC has assisted museum and heritage professionals at several venues with these transformative approaches, e.g. Black Country Living Museum, Birmingham Museums and Art Gallery (BMAG), the Museum of London and National Museums Liverpool.</p>
<p>2. Underpinning research (indicative maximum 500 words)</p> <p>Since establishing the Jewellery Industry Innovation Centre (JIIC) in 1997, Birmingham Institute of Art and Design (BIAD) has developed a leading position in research which brings new digital technologies (CAD/CAM, laser welding, laser scanning, rapid prototyping and laser sintering) into dialogue with traditional craft knowledge, skills and practices, in order to develop novel approaches to the design and manufacture of jewellery and other precious objects. Although used in a range of industries, the technologies had not previously been applied on the small scales demanded in the jewellery industry. The JIIC has now worked with over 400 companies, on a range of new product developments, realizing benefits such as reduced time to market and the manufacture of designs which would have been technically or economically challenging using traditional craft techniques. In conjunction with The Goldsmiths Company, JIIC published the first papers to explore and promote innovative applications for the jewellery industry of laser spot welding (Carey and Paynter 2004) and rapid prototyping (Carey and Cooper 2004), which remain significant points of reference in the field and were submitted in RAE 2008.</p> <p>In the decade following these publications the research has been extended to other sectors dealing with precious and fragile objects, specifically the heritage sector. Embracing the opportunities that have opened up in dialogue with curators, and adopting a practice-led, action research approach, researchers at the JIIC have developed a series of novel methodologies and working protocols with application beyond jewellery (Cooper 2011; Carey, Adcock and Forsyth 2013, Cane, Cooper and Symons 2013). These novel methodologies include:</p> <ul style="list-style-type: none"> • Adapting non-invasive laser scanning technology to cope with the difficulties in capturing data from very small, intricately decorated, highly reflective complex objects • Interpretation of the raw data to identify the visual clues of craftsmanship and manufacturing, leading to the suggestion of how an object was manufactured • Using digital visualisation software to build step-by-step scenarios of the manufacture of historic objects from start to finish presenting new perspectives without the damage of time • Replication of historic objects based on the analysed scan data and in combination with techniques such as rapid-prototyping, laser spot welding and traditional craft techniques, to reproduce precious artefacts in sympathy with their original fabrication. <p>A fundamental aspect of the work has been to understand the interrelationship between different technologies and how they map onto craft skills and practice, through curators, archaeologists, designers, technologists and craftspeople getting together to bring historical and precious objects alive in new ways. The combination of disciplines and skillsets has, through the use of adaptive technologies, enabled us to see and present artefacts as they would originally have appeared. The underpinning knowledge and research provides curators and heritage professionals with new methods of interpretation in the museum context. In turn, this enables visitors to touch and hold recreated precious artefacts in their original form, enriching the museum experience. This would</p>

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not previously have been possible without violating conservation practices and risking irreparable damage to the artefacts themselves.

3. References to the research (indicative maximum of six references)

Outputs A – C demonstrate our research expertise in utilising the emergent and often disruptive technologies in the jewellery industry. Outputs D – E demonstrate the fusion of craftsmanship knowledge and digital technology for the heritage sector.

- A. Carey, A.M. and Paynter. K. (2004) *Laser Spot Welding: Technical Guidelines and Innovative Applications for the Jewellery Industry*. London: The Goldsmiths' Company.
- B. Carey, A.M. and Cooper F. (2004) *Rapid Prototyping Applications for the Jewellery and Silversmithing Industries*. London: The Goldsmiths' Company.
- C. Cooper, F. (2012) 'Sintering and Additive Manufacturing: The New Paradigm for the Jewellery Manufacturer' 26th Santa Fe Symposium Proceedings, Albuquerque, New Mexico, pp 103–122. http://www.santafesymposium.org/papers/index.php?_a=viewProd&productId=289
- D. Cooper, F. (2011) 'A gift fit for a Pope, 1500 years after its creation', 25th Santa Fe Symposium Proceedings, Albuquerque, New Mexico, pp.123–144. http://www.santafesymposium.org/papers/index.php?_a=viewProd&productId=313
- E. Carey A.M., Adcock K. and Forsyth H. (May 2013) 'Rediscovering the Cheapside Hoard through Digital Visualisation', 27th Santa Fe Symposium Proceedings, Albuquerque, New Mexico, pp 113–132. http://www.santafesymposium.org/papers/index.php?_a=viewProd&productId=343
- F. Cane S, Cane D, Cooper F, Symons S. (Sept 2013) 'Using laser scanning and 3D technology to document and reproduce museum artefacts', *Metal 2013*, the triennial conference of the international Council of Museums Committee for Conservation Metal Working Group, Edinburgh. Co-Authorship with Birmingham Museum Trust, members of the International Council of Museums. pp. 43–48 <http://metal2013.org/sites/default/files/programme.pdf>

Outputs A and B were published by The Goldsmiths' Company (one of the Twelve Great Livery Companies of the City of London, Royal Charter granted 1327), which plays a leading role in promoting excellence in design and craftsmanship for the jewellery and silversmithing industry. These were commissioned and published as part of their 'Technical Research' series and are available online. Outputs C and D [see **Cooper** output 1] and E [see **Carey** output 2] were presented and published in the peer reviewed proceedings of the *Santa Fe Symposium*, which is now in its 27th year; this annual event is entirely industry sponsored and considered the premier not-for-profit educational forum for jewellery technology worldwide. Papers are available through an online directory. Output F: *Metal 2013* was a five-day meeting of the International Council of Museums committee for the Conservation (ICOM-CC) Metal Working Group. The metal working group is the conservation community's main body concerned with the conservation, restoration and preservation of all objects made of metal or metallic alloys of archaeological, indigenous, artistic or historical origin. The papers are peer reviewed.

4. Details of the impact (indicative maximum 750 words)

The application of re-emergent craftsmanship knowledge blended with digital technology to reconstruct and de-construct artefacts has allowed the detailed analysis of their original manufacture, form and materials. This in turn has enabled the re-manufacture of artefacts, to enable public exhibition and handling of objects by the general public. These impact benefits have resulted in the uptake of the techniques by practitioners, curators and conservationists in the jewellery and heritage sectors. Most significantly, the technology and associated protocols developed enable the museum sector to respond in new ways to the conflicting and complex balancing act of conservation, dissemination and access; digital technologies present novel solutions in bridging these demands. The deployment of these digital techniques has provided a conduit between the past and the present, allowing greater engagement for professionals and museum visitors with the artefacts and uncovering insights that would not have been possible previously. The application of the technology in these novel ways extends beyond current curatorial practice, facilitating changes in working practices that reach across a range of jewellery and heritage domains. This can be evidenced by the increasing reach of this interaction, first on a regional scale and now on a national scale, as seen below:

Black Country Living Museum, West Midlands (2008)

In one of the earliest projects with the heritage industry, the techniques described above were adapted to reproduce a series of historical insignia from the Dudley Borough Police and Postal Service for use in period museum costumes. The original steel stamping tools had been lost and to remake them would have been prohibitively expensive; therefore, working from the few remaining artefacts, held by The West Midlands Police Museum, replica insignia (buttons, rosettes, collar and helmet badges, helmet fittings and spikes, and belt buckles) were created. There is both qualitative and quantitative evidence for the impact of the research. In the period 2008–10 the museum received on average 300,000 visitors per year; and, most importantly, the replica artefacts formed a significant dimension of the visitor experience: “The visitor experience was enhanced and enriched by these authentic costume characters. The museum attracts a great number of visitors who pay great attention to detail as they are reliving *their* past experiences and memories” [Operations Manager, Black Country Museum, see corroborating statement 4].

Thus the application of JIIC processes presented a unique solution in recreating previously lost historical artefacts to address the integrity of these period costumes and enrich the experience of visitors to the museum.

Birmingham Museum Trust (BMT) (2009, 2011, 2013 and current)

2009 saw the initiation of a relationship of JIIC with the BMT that has continued to develop over the last few years in a number of different engagements.

2009 was the 200th anniversary of Matthew Boulton’s death; Birmingham City Council promoted a year long festival celebrating his life, work and legacy. Boulton was a leading industrialist and were he manufacturing today he would undoubtedly have embraced new digital technologies. Curators at Birmingham Museum & Art Gallery were keen that Boulton’s pioneering ethos of manufacture should continue in their exhibition – *Mathew Boulton: Selling what the world desires*, Gas Hall 30th May – 27th Sept 2009. BMT commissioned a set of replica candlesticks utilising the techniques described above whilst retaining the original design by Matthew Boulton. These replicas formed an educational handling exhibit for the exhibition and were seen by 32,700 visitors [see corroborating statement 3]. Copies were also made for a range of limited edition collectors’ items. These were available to purchase through the museum. This led on to further projects with the BMT, for example:

- ‘A gift fit for the Pope’ Cooper (2011) – an unfolded replica of the large ceremonial cross recently unearthed as part of the Staffordshire Hoard and presented to Pope Benedict from Birmingham City Council and the people of Birmingham during his visit in Sept 2010.
- An identical replica of the unfolded cross has been seen by over 600,000 visitors at BMAG.
- Current planning for the Staffordshire Hoard Galleries to open (2014). This research is allowing curators to radically rethink how they can exhibit, engage and disseminate their collections. BMT’s new Staffordshire Hoard Galleries are in development with plans in place to include replicas from the Hoard. JIIC has been commissioned to produce two replica items and negotiations for further work are taking place [see corroborating statement 3].

The Deputy Director of BMT has noted: “The impact of these initial studies has been significant...the manufacture of the replica items has created a focus for exploring practical and ethical frameworks for the interpretative display of the artefacts. For a collection in heavy demand, yet with complex display challenges, this is a significant benefit to the owning partners” [see corroborating statement 2].

Museum of London (2010-13)

It is just over 100 years since the Cheapside Hoard (predominantly Elizabethan and Jacobean jewellery) was discovered. With the current exhibition ‘London’s Lost Jewels: The Mystery of the Cheapside Hoard’ a Senior Curator at the Museum of London took the opportunity to review research on the Hoard. With many of the objects damaged or completely missing aspects of their design, our craftsmanship analysis offered possible clues to suggest how they may have looked. Virtual reconstruction sequenced the manufacture of the artefacts as they are now (damaged and missing elements) which in some cases presented a skeleton of precious metal; this was augmented to suggest how they would have looked 400 years ago, fresh from the workshop complete with pearls, enamels and stones. This collection is predominantly jewellery and as such was designed in relation to the body. To engage with the artefacts as originally intended, they

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should be worn and handled, not an activity usually associated with a museum visit. 3D metal printed objects produced from CAD and combined with traditional craftsmanship provided enhanced replicas, revealing for the first time how these objects would have looked. This research has directly affected how some of the exhibits will be displayed and how visitors can respond to the collection; for some exhibits the policy will be please touch! If a visitor is able to interact directly with a replica, hold it and turn it over, assess its weight and wear it, that becomes a significant learning experience and a valuable memory associated with that visit.

This collaborative project is the subject of a BBC4 3D Short film produced in 2011 [see corroborating statement 1] and, in anticipation of the Museum of London's major exhibition in October 2013, has also featured extensively in a number of different media publications, e.g. *New Daily Telegraph*, *Australia*, *Fox News*, *New York Times*, *New Scientist*, *North Korea Times*. A Senior Curator at the Museum of London has commented on the significant effect that this research has had "The results have prompted us to reappraise the work of the Elizabethan and early Stuart jeweller, and have added immeasurably to our understanding of contemporary craft skills, innovation and manufacturing techniques which enable us to start answering the question of how these artefacts were made 400 years ago" [see corroborating statement 1]. Our work has also featured elsewhere in the heritage sector, such as:

National Museums Liverpool (2008)

A replica Anglo Saxon brooch has been part of their permanent collection and available for visitors to examine and handle at the Weston Discovery Centre, World Museum.

Virtual Fossils (June 2012)

Our novel application of this technology was also seen in our collaboration with University of Birmingham for their 'Virtual Fossils' event as part of their Annual Community Day in June 2012. Rapid prototypes of the fossils were produced which enhanced the experience of visitors, as noted in some of the visitor feedback.

5. Sources to corroborate the impact (indicative maximum of 10 references)

Corroborating statement provided by:

1. Senior Curator, Post Medieval Department, Museum of London
2. Deputy Director, Birmingham Museums Trust
3. Director of Collections, Birmingham Museums Trust
4. Head of Projects and Interpretation, Avoncroft Museum (Previously Black Country Museum)
5. Director, The Goldsmiths' Centre

Impact within the media:

6. New York Times

http://www.nytimes.com/2013/11/13/fashion/a-famous-cache-in-all-its-splendor.html?pagewanted=3&_r=0

7. Fox News

<http://www.foxnews.com/tech/2013/07/28/2000-year-old-metal-coating-technology-cant-be-matched-even-today-for-use-in/>

8. North Korea Times

<http://www.northkoreatimes.com/index.php/sid/216013446/scat/d805653303cbbba8>

9. New Scientist

<http://www.newscientist.com/article/dn23921-17thcentury-gadget-gives-up-secrets-to-3d-printer.html>

10. Daily Telegraph Australia

<http://www.dailytelegraph.com.au/technology/sci-tech/ancients-used-nanotechnology-to-make-jewellery/story-fni0c0qg-1226685206755>