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Abstract
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EMBRACING HISTORICAL REPLICAS THROUGH A DIGITAL MEDIUM

THE IRISH CONTEXT

CREATING REPLICAS of cultural artefacts and artworks has long been recognised as a useful method to study the original objects in a new way. Recent years have seen an upsurge in interest in historical replicas, however, with many institutions bringing their replicas back into the public consciousness. At the same time, museums and cultural institutions are looking for ways to integrate new digital technologies into their work. This is often accomplished through methods of 3D recording and is, in essence, creating digital replicas of original artworks. This short paper will reflect on Ireland's collections of replicas (from the historic to the digital) and discuss some future work that will be undertaken as part of a collaborative project on Irish replicas.¹

If you follow Francis Haskell and Nicholas Penny's line of thought in their volume *Taste and the Antique: The Lure of Classical Sculpture, 1500-1900*, the main reason behind the

initial proliferation of copies and replicas of cultural objects is demand.² It was the popularity of the classical canon, consisting of sculptures such as the Apollo Belvedere and the Laocoön, that first instigated the creation of copies for royal courts; because the originals of those



Figure 1 Object-scanning the Market Cross in Kells, Co Meath

works could not be viewed outside of Rome, copies were made and disseminated throughout Europe. This in turn led to the creation of plaster cast collections for educational purposes, especially in art academies and national collections whose primary aim was the education of the general public. At a later stage, the value of replicas was recognised for preservation and conservation purposes. Nowadays, we are beginning to recognise their cultural heritage and tourism potential, as well as their value in research.

EDUCATION AND DISSEMINATION AS REASONS FOR MAKING REPLICAS

Replicas have long had a role to play in education, and it would appear that this is continuing. In Ireland, as elsewhere, historical replicas used for educational purposes can be grouped into two categories: those used in art instruction and those used in public museums.

Although there were a number of Irish institutions concerned with artists' education (including the Crawford School of Art and its collection of so-called Canova Casts),³ the Royal Dublin Society Drawing Schools (that would ultimately become the National College of Art and Design) had the largest collection of plaster casts. It already had a collection of plaster casts from around 1751. The casts were used for art instruction until the 1960s (in what had become the National College of Art and Design)

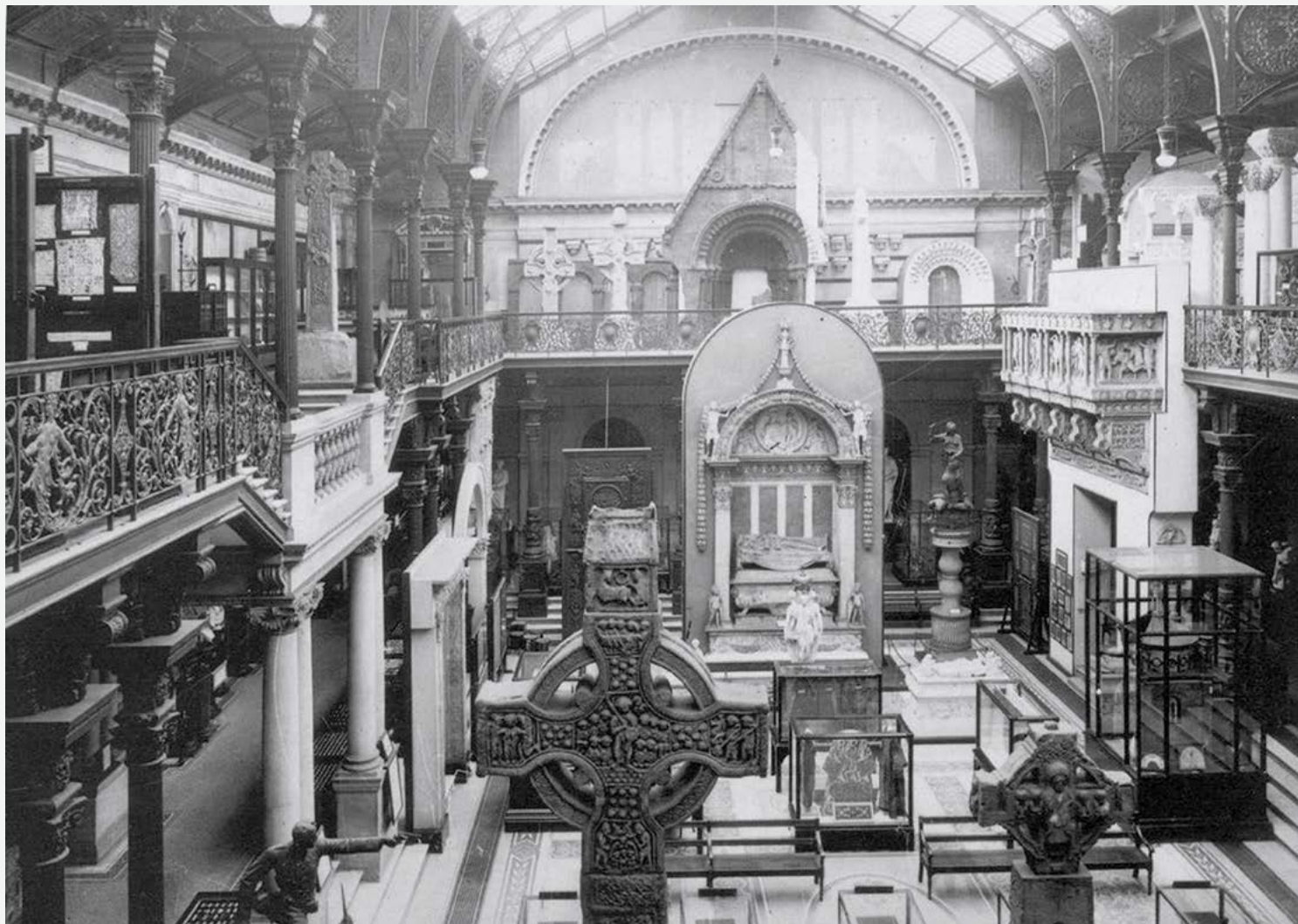


Figure 2

The interior of the Dublin Science and Art Museum, now the National Museum of Ireland: Archaeology, early 20th century, showing various plaster casts of high crosses

A major theme in the digital revolution is open access, democratic learning.

when some of them were unceremoniously smashed by two protesting students.⁴ Nowadays students at the National College of Art and Design are no longer required to draw from casts; students on the Industrial Design course are instead required to present their work in digital format using 3D modelling. This is one of the most direct parallels between historical replicas and digital ones—students have simply shifted to a new form of production.

Another very real parallel between historical and digital replicas can be found in their use in educating the public. Replicas such as plaster casts were one way of transmitting information prior to the digital age. Particularly in Britain and Ireland, cast collections formed part of a new emphasis on “public education”; institutions like the National Gallery of Ireland and the National Museum of Ireland were established with a remit to assist in educating the public, and were equipped with collections of replicas accordingly.⁵

A major theme in the digital revolution is open access, democratic learning. The Smithsonian’s new X 3D Explorer is a good example of this democratic approach to museum collections.⁶ The project creators refer to this as the “end of the ‘do not touch’” approach. They entice us: “Use the Smithsonian X 3D Explorer to explore and manipulate museum objects like never before. Create and share your own scenes and print highly detailed replicas of original Smithsonian collection pieces.” The Metropolitan Museum of Art in New York has taken a similar approach, inviting users to actually “take home” a copy of their works of art.⁷ Although Irish museums have yet to adopt this method, it seems a distinct possibility for the near future.

DEMAND AND PRESTIGE AS REASONS FOR MAKING REPLICAS

As is well-documented,⁸ royal collectors played a major role in the early collecting of copies. In Ireland’s case, the Grand Tour caused an influx of both originals and copies of classical art in the country. Ultimately, having copies of famous works of arts became synonymous with prestige; no large country house⁹ or major public museum of the nineteenth century was complete without them.

It could be argued that demand is again driving the creation of replicas, but now in a digital format. Digital technologies often have a level of appeal that more traditional methodologies lack, and the 3D printing industry is currently booming. Ireland and Northern Ireland are tapping into the FabLab movement, with new branches recently opening in Derry, Belfast, Limerick and Cloughjordan, Co. Tipperary.¹⁰ Commercial-level 3D printing in Ireland is expanding rapidly and this trend looks set to continue with cultural heritage practitioners joining the fray.



Figure 3 3D visualisations in Meshlab generated from the scanning, the original on the left and replica on the right

REPLICAS AND CANON FORMATION

In another sense, the ‘prestige’ of certain works of art and the creation of a canon, as well as the idea of an ‘icon’, are still integral to the creation of replicas today. For example, the recent EU-funded “3D-Icons” project aimed “to digitise in 3D architectural and archaeological monuments and buildings identified by UNESCO as being of outstanding cultural importance”; along with monuments with UNESCO designation, project leaders in individual countries were tasked with digitising examples of such structures that they viewed as occupying a prominent place in our international consciousness.¹¹

DOCUMENTATION, PRESERVATION AND CONSERVATION AS REASON FOR MAKING REPLICAS

Replicas can also exist to act as protection for the originals. A notable example of this in Ireland is the erection of a replica of what is known as the “Cross of the Scriptures” at the early medieval church site of Clonmacnoise, Co. Offaly. The replica was placed in the location formerly occupied by the original cross, which was moved inside the newly built heritage centre in order to protect it.

While in the past we had to rely primarily on visual inspection and photography to assess the condition of cultural

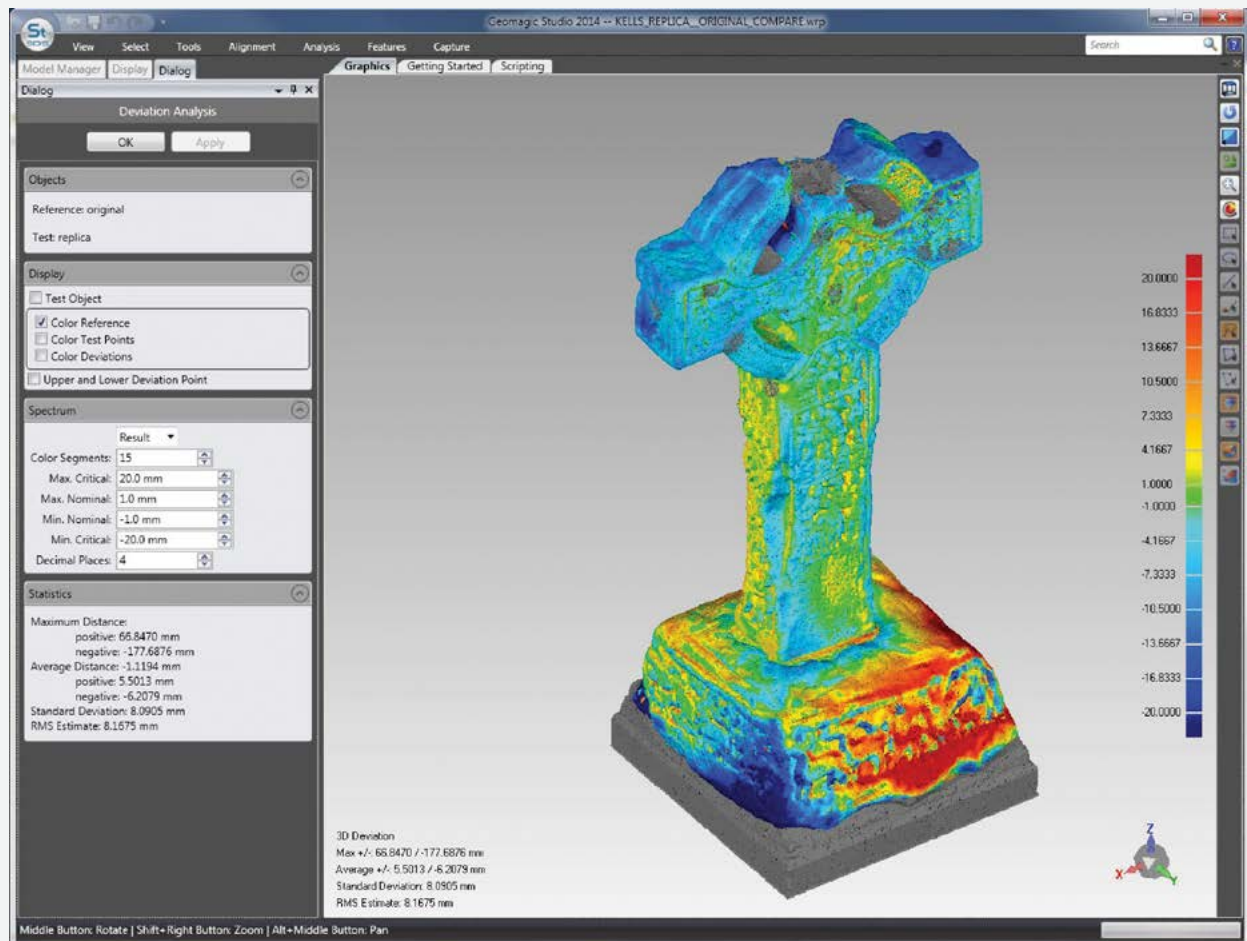


Figure 4

The basic results of deviation analysis between the complete 3D models of the original and replica of the Kells Market Cross

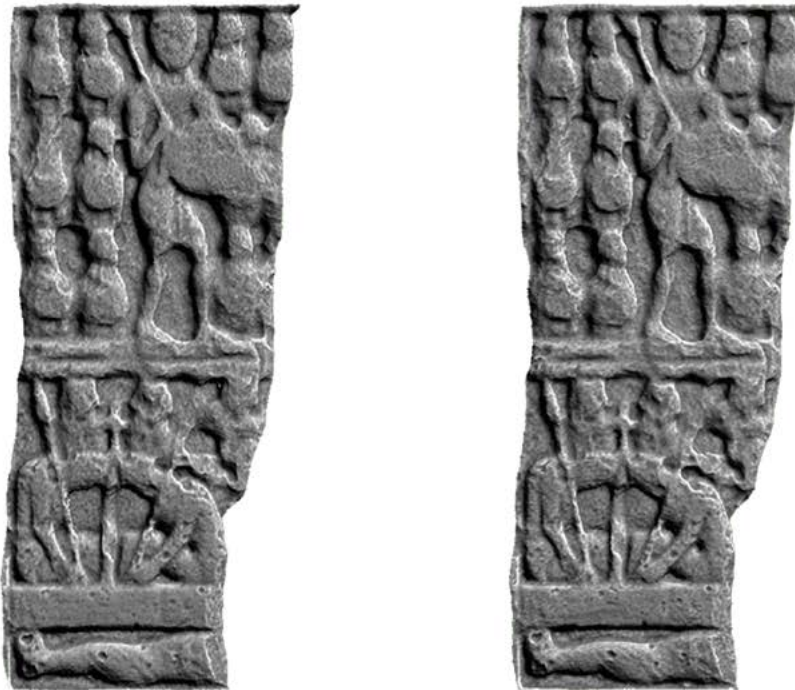
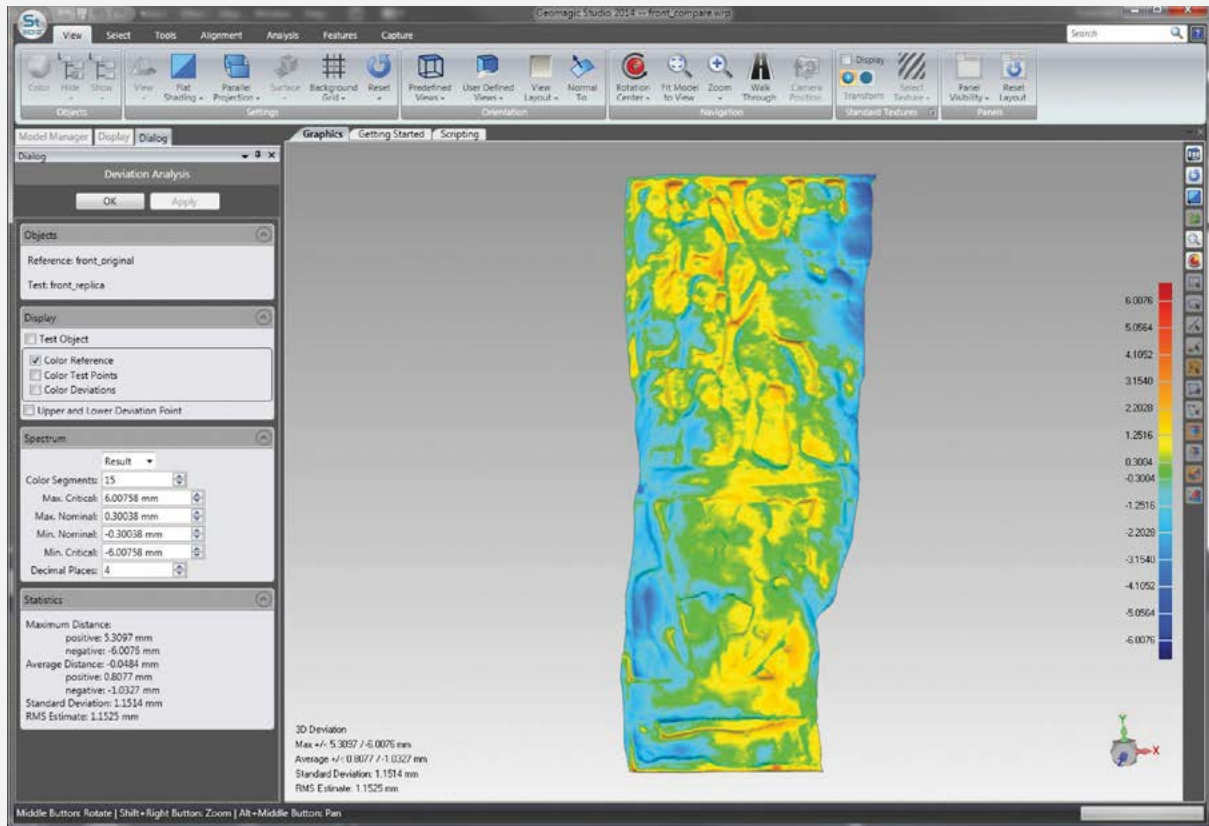


Figure 5

Deviation analysis results between the original and replica for a detailed panel on the front of the Kells Market Cross

objects, we can now utilise state-of-the-art 3D documentation techniques. The Discovery Programme has a long-standing research interest in 3D documentation and analysis including historic landscapes, built heritage and cultural objects. This began in the early 1990s with a 3D model generated from traditional ground survey measurements of the complete royal landscape at Tara, Co. Meath. This ground-breaking terrain model revealed previously unknown micro-topographical features and proved an invaluable resource in the analysis and further understanding of the landscape.¹² It embedded the belief in 3D modelling as a primary documentation method, cemented by our involvement in collaborative EU projects such as “Archaeolandscapes”, which revealed the power of aerial systems such as lidar and the application of advanced algorithms for visualisation.¹³

Terrestrial laser scanning, generating high density point-clouds, was introduced in 2005 to survey and record upstanding monuments and excavations, using instruments such as the Faro Focus 120 phase-based scanner. Thanks to its precision of approximately 2 mm, this scanner can precisely model the complexities associated with historic structures, and was central to a major EU research project that researched the process pipeline to record, create and deliver 3D models to the public.¹⁴ The 2-mm resolution achieved with terrestrial laser scanning, although appropriate for documenting complete structures or buildings, was found to be inadequate for the fine detail of decorated stone carving or sculpture.¹⁵ This challenge first presented itself through our participation in the “Ogham in 3D” project.¹⁶ Ogham stones bear inscriptions in the Ogham alphabet, which uses a system of notches and horizontal or diagonal lines/scores to represent an early form of the Irish language. The “Ogham in 3D” project aimed to generate 3D models of all the stones in state care in Ireland; a structured light scanner, an Artec EVA, was used for this.¹⁷ This hand-held instrument modelled the surface to a resolution of 0.5 mm, sufficient to reveal even the faintest carvings.¹⁸

Following this successful application of the scanner, the instrument was used for some of the most challenging aspects of the “3D-Icons” project, the high crosses of



Figure 6

Comparison of Artec EVA scan data from a historic plaster cast replica (Royal Society of Antiquaries of Ireland) and the carved stone original of a detail panel, the Hound Lord, from the Kells Market Cross

How well do the replicas appear to have been made?

Do the replicas and/or moulds preserve details that are now lost on the original?

Has smoothing or embellishment taken place?

Ireland. These ornately carved stone crosses, often standing more than three metres high, presented significant logistical challenges but resulted in models of exceptional quality that are excellent resources for interpretation. It is hoped that these models can also be used as an aid in the future preservation and conservation of carved stones in Ireland.

The 3D models of the high crosses generated significant interest and discussion, which inevitably led to consideration of Ireland's collection of historical replicas. The National Museum of Ireland holds a number of important high cross plaster casts from the early twentieth century that were originally displayed in the museum's Kildare Street branch [Figure 2](#).

Given the level of detail being recorded by scanning the originals, could a framework of research questions be established that could be answered by scanning the replicas or even the moulds used to create them?¹⁹

- 1 Quality and geometry. How well do the replicas appear to have been made? Do the overall geometry and metrics match the original? Is there any distortion or twisting? How are the complex elements with depth represented?
- 2 Erosion and decay. If the original has been left exposed to the elements, could a scan of both replica and original detect and quantify change? Do the replicas and/or moulds preserve details that are now lost on the original?
- 3 Authenticity. In finishing the replicas, has smoothing or embellishment taken place?

A good example is the Market Cross in Kells, Co Meath.²⁰ An Artec EVA scanner was used to record the original and a complete poured-concrete replica [Figure 2](#). The image on the left shows the original carved stone cross, which is currently located outdoors under a protective glass canopy, while the image on the right shows the poured-concrete replica, made in 1997, which is housed in the former heritage centre. 3D models were developed for both crosses and the two surfaces compared, first visually in Meshlab using the Radiance Scaling Shader, and then by using a deviation analysis.

Can we differentiate between the potential processes of erosion, smoothing and/or embellishment?

The visual inspection confirmed the remarkably high quality and consistency of detail represented in the replica, the quality of the overall craftsmanship, and the suitability of the objects for further analysis. [Figure 3](#) Deviation analysis between the two models revealed problems associated with such complex 3D objects. Attempting to register the complete model surfaces continually compromised the quality of the local fit, and so far has proved unsatisfactory, although it proves the overall geometry is good [Figure 4](#). The largest deviations are due to the incomplete base on the replica; however, the overall RMS of 8.16 mm does not give a firm basis on which to consider in detail the deviations in local areas. Deviation analysis of extracted panels from the complete cross [Figure 5](#) has proved more rewarding. For this sample from the front of the cross, the deviation RMS is considerably lower (1.15 mm) and reflects the high quality of the replica. Access to a second cast, this time a single panel from a historical plaster cast replica of the Kells Market Cross, the Hound Lord, underlined the complexity of analysing casts [Figure 6](#).²¹ Deviation analysis of scan data again quantified the variations but a visual inspection easily identified major differences between the models. For example, the feet of the beasts appear exaggerated and enhanced in the replica, as do the beard and moustache.

The interesting and challenging problem is how to explain and account for the deviations. As other researchers have observed, a complex set of variables are potentially involved and it may not always be possible to resolve this issue.²² Initial research questions include:

- 1 How do we define the “best fit”? Is this even an appropriate first step?
- 2 Does attempting to determine the best fit for complete models adversely impact the analysis of individual carved panels?
- 3 Can we differentiate between the potential processes of erosion (the original has been outdoors), smoothing and/or embellishment?

The flexibility of the 3D-model environment also allows for experiments, for example, tests with colour to explore the “painting” of the High Crosses.²³

As will be clear from this brief reflection, replicas have the ability to inform a number of areas. More work is needed on both historical and digital replicas in Ireland, but it is clear that they are important components of Irish cultural heritage. We hope that the historical replicas can inform the future creation and function of new digital replicas, and that digital technologies will allow us to look at the significance of historical replicas in a new light.

- 1_ This work is being undertaken in collaboration with the Irish Research Council-funded ‘Breaking the mould’ project (a partnership between University College Dublin and CRDS Ltd.) and the Discovery Programme’s ‘Digital Replicas Project’.
- 2_ F. Haskell and N. Penny, *Taste and the Antique: The Lure of Classical Sculpture, 1500-1900*, Yale University Press, New Haven, CT 1982.
- 3_ On the Crawford collection see P. Murray, *The Crawford Municipal Art Gallery*, The Crawford Gallery, Cork 1991.
- 4_ For the most complete history of the College of Art see J. Turpin, *A School of Art in Dublin since the Eighteenth Century*, Gill & Macmillan, Dublin 1995.
- 5_ For a history of Irish museums, see Marie Bourke, *The Story of Irish Museums, 1790-2000: Culture, Identity and Education*, Cork University Press, Cork 2011.
- 6_ Smithsonian Institution, *Smithsonian X 3D: getting started* <http://3d.si.edu/article/getting-started> last accessed 02/02/2016
- 7_ The Metropolitan Museum of Art, *Digital underground: 3D scanning, hacking and printing in art museums, for the masses* <http://www.metmuseum.org/about-the-museum/museum-departments/office-of-the-director/digital-media-department/digital-underground/posts/2013/3d-printing> last accessed 02/02/2016
- 8_ Haskell and Penny, (as note 2), pp. 2-5.
- 9_ Examples of country houses in Ireland that held cast collections include Russborough House and Powerscourt House, both in Co. Wicklow. For more information on Russborough’s collection of copies and original works of art see W. Laffan and K.V. Mulligan, *Russborough: A Great Irish House, its Families and Collections*, The Alfred Beit Foundation, Russborough, Co. Wicklow 2014.
- 10_ Derry and Belfast: <http://www.fablabni.com/centre/fablab-nerve-centre> last accessed 12/02/2016; Limerick: <http://fablab.saul.ie> last accessed 12/2/2016; Cloughjordan, Co. Tipperary: <http://wecreate.ie> last accessed 12/02/2016
- 11_ “3D-Icons” project website <http://www.3dicons-project.eu> last accessed 2/2/2016; for the Irish contribution to this project see *3D-Icons Ireland* <http://www.3dicons.ie> last accessed 2/2/2016

- 12_ C. Newman, *Tara: An Archaeological Survey* (Discovery Programme, Monographs 2), Royal Irish Academy, Dublin 1997.
- 13_ “Archaeolandscapes” project website (<http://www.archaeolandscapes.eu>; last accessed 2/2/2016); A. Corns and R. Shaw, ‘Lidar and World Heritage Sites in Ireland: why was such a rich data source gathered, how is it being utilised, and what lessons have been learned?’, in: R. Opitz and D. Cowley (eds.), *Interpreting Archaeological Topography*, Oxbow Books, Oxford 2013, pp. 146-160.
- 14_ “3D-Icons” project website; A. Corns, A. Deevy, G. Devlin, L. Kennedy and R. Shaw, ‘3D-ICONS: digitizing cultural heritage structures’, *New Review of Information Networking*, 20:1-2, 2015, pp. 59-65.
- 15_ M.J. Wachowiak and V.K. Basiliki, ‘3D scanning and replication for museum and cultural heritage applications’, *Journal of the American Institute for Conservation*, 48:2, 2009, pp. 141-58.
- 16_ “Ogham in 3D” is a partnership between the Discovery Programme and the Dublin Institute of Advanced Studies.
- 17_ Artec Eva specifications <http://www.artec3d.com/hardware/artec-eva#specifications> last accessed 02/02/2016
- 18_ G. Devlin, F. Moore, R. Shaw, N. White, ‘Ogham preserved digitally – 3D technology for a 3D script’, *Archaeology Ireland*, 29:112, 2015, pp. 12-15.
- 19_ M. Hess and S. Robson, ‘Re-engineering Watt: a case study and best practice recommendations for 3D colour laser scans and 3D printing in museum artefact documentation’, in: D. Saunders et al. (eds), *Proceedings of Lacona IX-lasers in conservation of artworks*, Archetype, London 2012, pp. 154-62.
- 20_ This replica appears to be of poured concrete, but details of its manufacture have yet to be confirmed.
- 21_ This panel belongs to the Royal Society of Antiquaries of Ireland. For more information, see M. A. Bevilino, ‘Two recently restored high cross replicas in the collection of the Royal Society of Antiquaries of Ireland’, *Journal of the Royal Society of Antiquaries of Ireland*, 142/143 (2012/2013), 2015, pp. 214-17.
- 22_ B. Frischer, ‘3D data capture, restoration and online publication of sculpture’, in: F. Remondino & S. Campana (eds), *3D Recording and Modelling in Archaeology and Cultural Heritage: Theory and Best Practices*, BAR International Series (S2598), 2014, pp. 137-144.
- 23_ F. Horn, ‘Virtual colour reconstruction performed on the 3D model of a selected figure from the Terracotta Army’, *Testing and optimising conservation technologies for the preservation of cultural heritage of the Shaanxi Province, PR China* (Final Report), Museum of the Terracotta Army/Bavarian State Department for the Preservation of Historical Monuments, 2006, pp. 35-99.