

The use of Additive Manufacturing technology for the aesthetic restoration of ceramic and glass artefacts: the research so far.

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Introduction

Aesthetic restoration treatment is typically the last stage of the conservation process applied to an artefact, following the treatments of stabilising and cleaning. Technological advances, such as Additive Manufacturing technology, can complement traditional aesthetic restoration to produce results that may be more objective, particularly in terms of repeatability. They may also provide new solutions in restoration and reassembly of missing parts, improving and advancing the aesthetic restoration treatments overall. This research is applying, testing, and evaluating additive manufacturing technologies and materials and their suitability for aesthetic restoration of ceramic and glass artefacts by recreating missing parts and, where possible, reassembling them. At the end of the above process will be evaluated regarding the aesthetic outcomes, the time and cost involved, and other implications for object conservation. This poster presents the progress of this research so far.

Research Question

- What are the applications and limitations of the current Additive Manufacturing technology and materials used for the aesthetic restoration of ceramic and glass artefacts?
- What potential developments could be seen in future applications, taking into consideration the current AM approaches and new AM innovations, potentially stimulated in conservation needs?

Methodology

- Exploring case studies of ceramic and glass objects
- Interviewing curators and conservators from museum about their expectations
- 3D capturing of objects with the method of photogrammetry
- Digital restoration of missing parts
- Exploring case studies of ceramic and glass objects

- Interviewing curators and conservators from museum about their expectations
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- Digital restoration of missing parts
- Analysis of potential ceramic and glass additive manufacturing materials
- Oddy testing of additive manufacturing materials to evaluate their long-lasting performance for conservation proposes



Figure 1: Objects of the case study from the British Museum. From left to right:
 • Earthenware glazed figure, China, Tang dynasty, 618 – 906 AC
 • Red figured pottery, Greece, Attic period, 500 BC – 480 BC
 • Glass blue bowl, Syria, Ayyubid dynasty, 13th century A

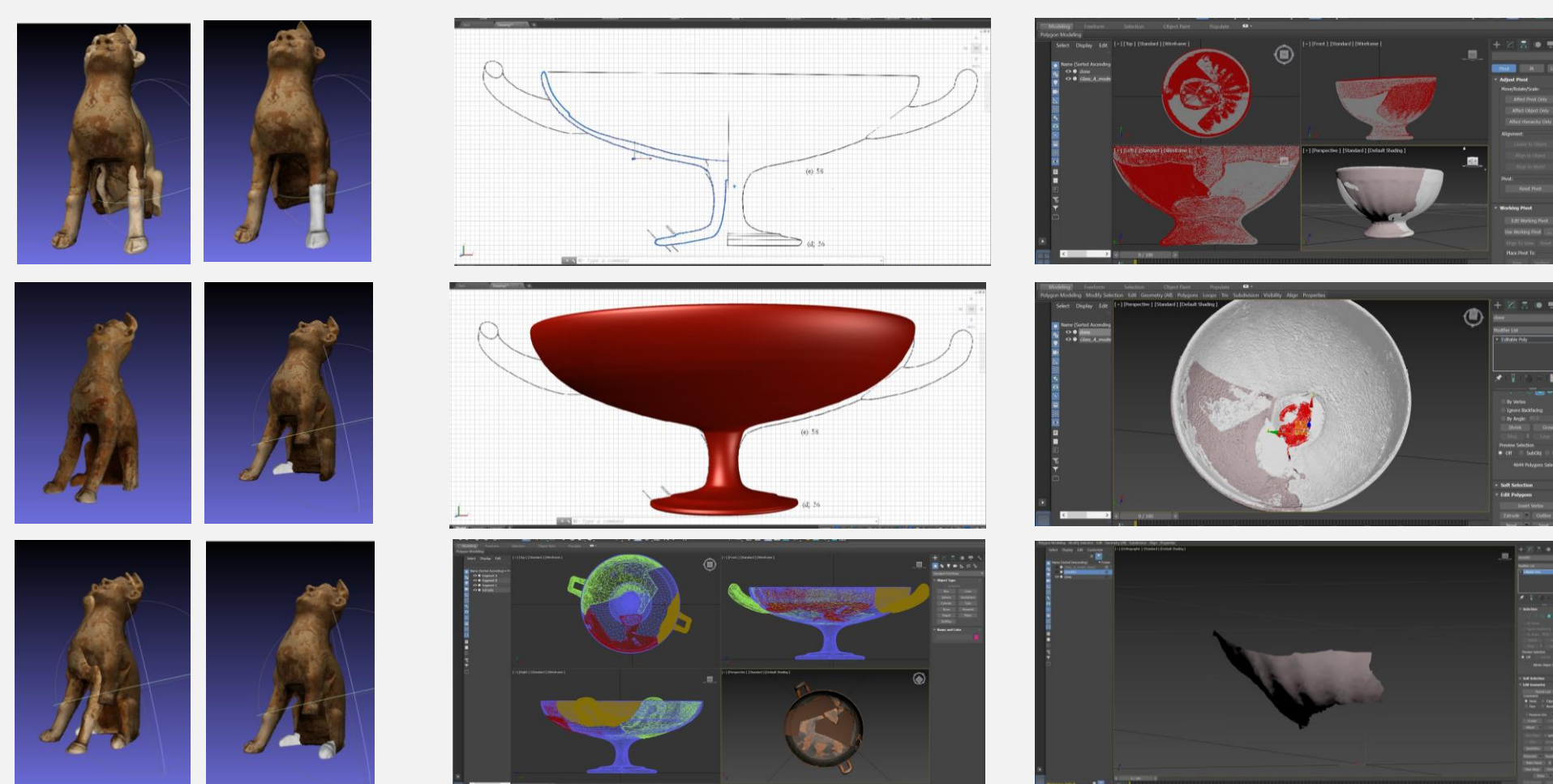


Figure 2: Digital restoration process. Different approaches were followed, depending on the case: a second similar object was used to restore the missing parts (left), a new object was created from an archaeological drawing (middle), the same object was used to restore the missing parts (right)

| Organisation/ suppliers | Contacted | Replied | Agreed to contribute | Total number of materials |
|-----------------------------|-----------|---------|----------------------|---------------------------|
| Ceramic/ceramic-like | 9 | 4 | 1 | 6 |
| Glass/glass-like | 34 | 1 | 1 | 2 |
| Institutes and Universities | 7 | 7 | 3 | 9 |

Table 2: The number of AM organisation and suppliers which were contacted, replied, agreed to contribute to this research and the final number of selected materials.

Results (so far)

| Objects | Total time until final 3D models | Time for digital restoration of missing parts | Total time spent until the creation of the missing parts |
|---------------------------------|----------------------------------|---|--|
| Chinese figure | 13 h & 5 m | 35 m | 30 h |
| Greek Attic (fragments A, B, C) | 21 h & 35 m | 3 h & 30 m | 25 h and 5 m |
| Islamic glass bowl | 7 h & 15 m | 4 h | 11 h and 15 m |

Table 2: Time spent for the creation of the 3D models, the digital restoration of the missing parts and the total time spent until this point.

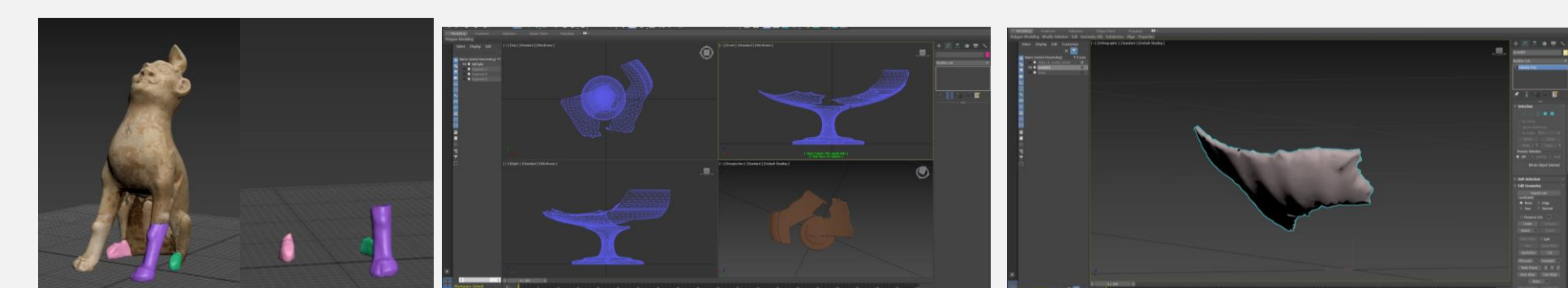


Figure 3: The missing parts after their digital restoration:
 • The three missing legs of the figure (left)
 • the missing parts of the pot, as one part (middle)
 • and the missing part of the glass bowl (right)

| Organisation/ suppliers | Suitable for long term use | Suitable for short term use | Unsuitable for use |
|-----------------------------|----------------------------|-----------------------------|--------------------|
| Ceramic/ceramic-like | 1 | 5 | 0 |
| Glass / glass-like | 0 | 1 | 1 |
| Institutes and Universities | 1 | 7 | 1 |

Table 3: The results from the Oddy test of the AM materials.

Next steps and further study

- Creation of missing parts and final restoration of artefacts
- Cost benefit analysis (aesthetic result, material properties, accuracy of the printed object, financial outlay and time)
- Holistic discussion of the application of Additive Manufacturing technology to conservation practice
- Creation of a framework for conservators to apply the outcomes of this research in conservation practice

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