HOW IT WAS MADE:

A TANGIBLE REPLICA WITH MOBILE AR

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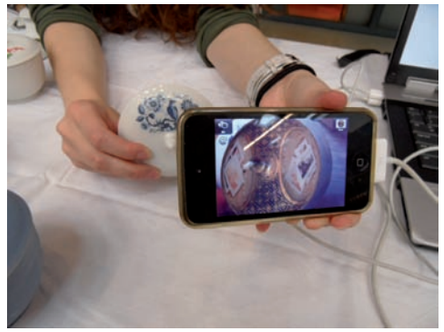

Replicated cup and lid in porcelain, augmented by animated 3D graphics on a smartphone.

As part of the “Smart Replica” theme initiated by Maaike Roozenburg, we made a proof of concept in the minor on Advanced Prototyping at the Faculty of Industrial Design, Delft University of Technology. The top figure presents an impression of the final result: an exact replica in porcelain of an 18th century sugar cup + lid, the decorations function as markers for a handheld AR overlay. On the cup, the augmentation is a 3D animation floating on top of the physical object, while the physical lid is covered exactly with a virtual golden decoration that matches the original lid.

Most of the technologies that we used require only a basic skill level with some experience in 3D modeling (CAD or visualization). A close account of this developmental process can be found on the weblog http://porcelain2011.weblog.tudelft.nl Below, the most essential steps are discussed.

3D scanning

The original Loosdrecht’s porcelain objects are part of the collection of museum Boijmans Van Beuningen. They measure approximately 8 cm and due to their fragility non-contact scanning had to be selected. A medical Computer Tomography scanner was employed, in which a radiation source and the detectors rotate around the sample and measure the attenuation of the x-rays of the sample from different angles. In the slice the pixel resolution is approximately 0.2 mm, yielding a result which is still sufficient to inspect object thickness and geometry. Furthermore, the scans gave a surprising effect: the gold decorations (“goudluster”) caused distortions in the scanned geometry.

3D Reconstruction

A substantial part of the reverse engineering is the digital reconstruction of the scanned point clouds into a valid, 3D CAD model that is printable. In this case, much effort was spent to convert the collection of jpeg pictures of 2D slices into a valid 3D mesh. However, this was not possible given the time constraints and we ended up extracting a vertical section view to generate a working revolve in *Rhinoceros* - a regular type of CAD package.

In the cup, an AR tag was embossed, to be used as an optical marker. A 3D print was made with a polyjet technique in maximum resolution (an Objet Eden, accuracy 16 micron).

Manufacturing and decoration

Based on the 3D prints, molds were made in plaster to pour the porcelain clay into. After drying the mass, the molds were carefully removed, baked and painted, after which a final transparent glaze was applied.

Augmentation

For mobile AR, we chose *Junaio* – a straightforward smartphone application that offers location-based augmentation as well as image recognition. The so-called GLUE functionality allowed us to overlay 3D models and animations on top of predetermined images (pattern) with a web-based interface to adapt the scale, rotation, and position of the objects. For modeling we used *3D Studio Max*, which could export in the proprietary .md2 format with a special plugin. The augmentation of the lid was a gold version of the same object, which was simply a modified version of the same reconstructed 3D file of the lid. The cup was extended with an animation of several portraits that seemed to float in the air.

Acknowledgements

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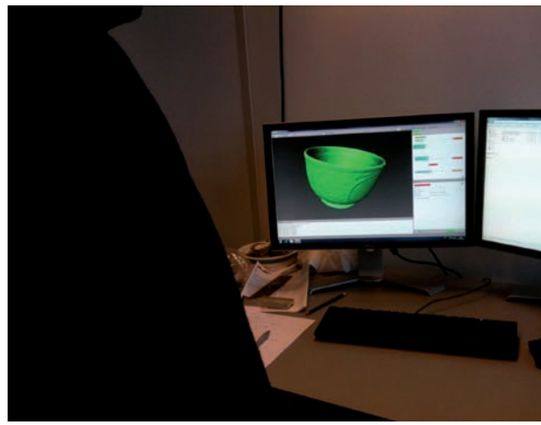

Original Loosdrecht sugar cup and resulting mesh model after the CT scan.