Textdatenbank und Wörterbuch des Klassischen Maya

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# Evaluating the Digital Documentation Process from 3D Scan to Drawing

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The "Text Database and Dictionary of Classic Mayan" project acquired a *Breuckmann smartSCAN C5* structured-light scanner for high-resolution and three-dimensional documentation of Maya artefacts with inscriptions. Renderings of the stereolithographic mesh can be used to create (digital) line drawings for the project's repository. This working paper exemplifies the workflow of creating a drawing on the basis of a mesh (rather than describing the scanning and mesh generation process themselves) in order to evaluate a best practice and define standards for the project.

## Scanning and 3D Mesh Rendering

A fibre glass replica of the left slab of the Tablet of the Sun from Palenque was used as a case study for the documentation process. This cast is part of the collection of the *Bonner Altamerika-Sammlung* (BASA) at the University of Bonn. It was made from the same mould that was previously used for the cast made by Maudslay (1889: pl. 87). To imitate the original surface, the replica was coated with a yellow-brownish paint mixed with small particles, imitating a surface of porous stone. The scanner's M-850 sensor was used for the scanning process. It has a field of view size of 650 x 560 mm with a 27° triangulation angle. The lateral resolution (X,Y) is 265 µm and the depth resolution (Z) is 15 µm. A series of 17 raw shots was assembled into a merged mesh, with a total of nearly 6.55 million vertices and 13.06 million faces, and saved in the binary polygon file format (PLY) in Breuckmann's *Optocat* software.

In the next step, the mesh was processed with the Open Source software *Meshlab* to produce a rendering suitable as a basis for the line drawing. After aligning the model to an isometric view of the relief, the colour information was deactivated, leaving the mesh un-textured. This makes the outlines of the surface more visible, but a Phong illumination (Phong 1975) still retains shadows and the plasticity of the original surface. As a last step, a Lambertian radiance scaling (Vergne et al. 2011) shader was applied with maximum enhancement to reduce specular lights for a matte surface, to

highlight and "flatten" relief contours, and to provide a rendering with sufficient contrast to facilitate tracing of carved outlines. The rendering was then exported as a high-resolution snapshot.

**Figure 1. Courtesy Bonner Altamerika-Sammlung (BASA) – Meshes by Sven Gronemeyer, 2015 – left: Textured full-colour Phong rendering, center: Uncoloured Phong rendering, right: Lambertian radiance scaled rendering**

## Image Processing

The snapshot can, of course, be printed out in a preferable size and the line drawing then completed using ink and paper, but a more desirable option is further digital processing and drawing. For this purpose, the project offers each epigraphic team member a *Wacom Cintiq 24" HD* interactive pen display and a variety of graphic suites as per individual preference. One of the major advantages of an image editing software is the possibility of creating multiple layers for the mesh, the drawing, and the background. This leaves the artist the freedom to divide the drawing into custom segments of various granularity, e.g. creating layers for each individual glyph block or iconographic feature. For the Tablet of the Sun showpiece, it was decided to arrange layers for (a) the mesh rendering, (b) the feature outlines of thicker line width, (c) the inner contours of thinner line width, and (d) the background(s) of blank spaces in the relief. The drawing thus follows the technique established as the standard for the *Corpus of Maya Hieroglyphic Inscriptions* (Graham 1975: fn. 4).

The layer organisation does not only facilitate the drawing process. Within the team, layers can also help team members discuss interpretations in the drawing process and propose corrections or amendments. Layers additionally ensure stringent quality control in a collaborative work flow. But, above all, a drawing layer on top of the mesh rendering provides more transparency to other colleagues by allowing direct comparison between the rendering of the scanned object and the artist's

treatment of surface features, at least by using the radiance scaled image in the background. While tracing on this basis, the artist still has the possibility to simultaneously view the 3D mesh from different angles with different illumination settings and shaders, and to dynamically inspect surface features that become fixed in the snapshot.

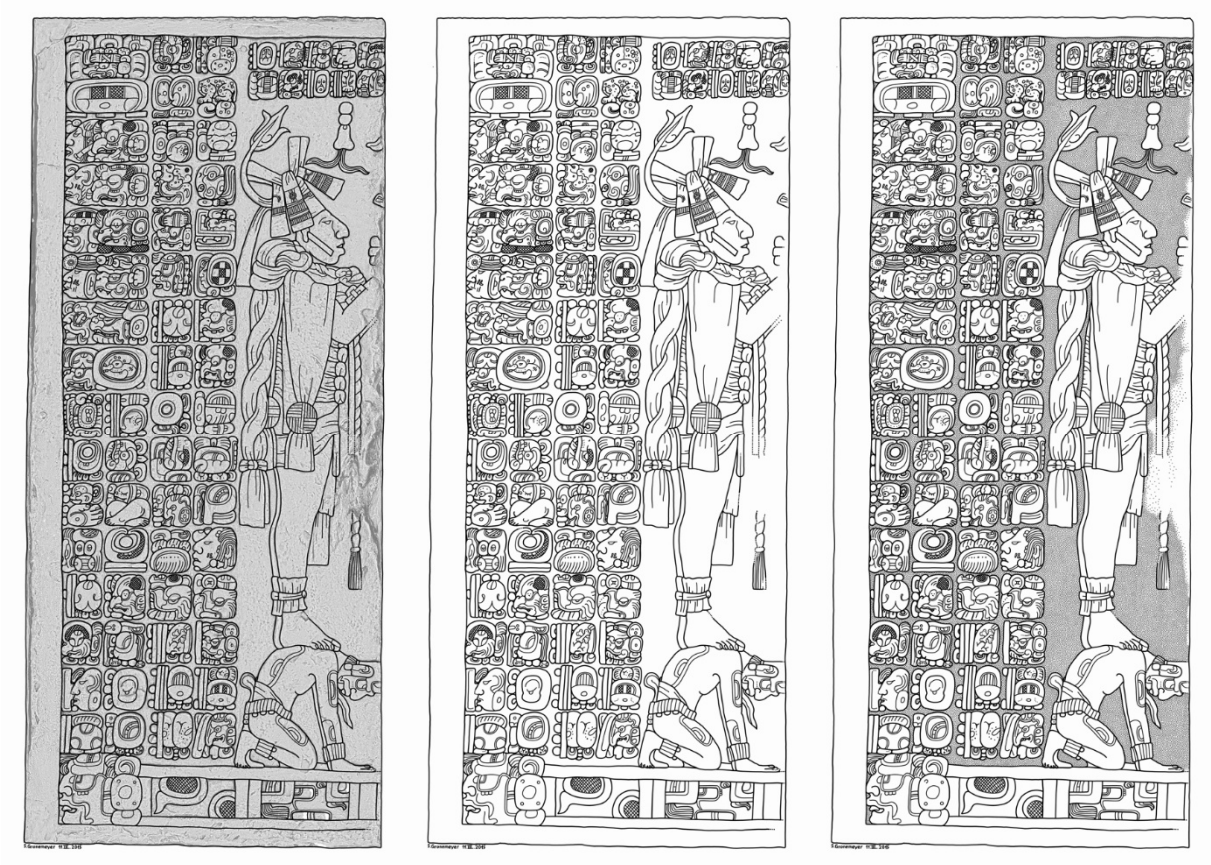

**Figure 2. Different Drawing Layers of the Palenque Tablet of the Sun – Drawings by Sven Gronemeyer, 2015 – left: mesh and outline drawing, center: drawing without background, right: drawing with background stippling**

A final comment can be made on the background filling. The method of stippling the background to highlight the carved areas was of course necessary when using ink and paper. In digital image processing, however, a mask of the outlines can easily be produced and filled with a range of uniform, grey colours. A major argument in favour of this method is time: in the present example, the stippling required about 20 hours of work, although it is admittedly rather dense. Filling the mask, in contrast, took only about 30 minutes. A grey background is also not expected to be problematic for modern print technologies, and layers furthermore allow different output options to suit any reproduction requirement, whether online or in print. In total, about 50 hours were needed to finalise the drawing.

## Recommendations

Based on the experience working with the Tablet of the Sun showpiece, the project proposes the following guidelines for generating line drawings based on 3D scans:

- Create a high-resolution snapshot of the prepared mesh rendering; its physical dimensions depend on the size of the object

- Assign a layer to the rendering, making it the lowest level on top of a white background
- Assign each major feature (e.g. glyph block or figure) different layers for outer and inner lines; the thinnest line width should be no less than 5 pixels
- Create a mask to contain the background filling: 20% black is recommended (= Hex #CCCCCC = RGB 204)
- Leave the interior of glyph blocks, iconographic features, frames, and eroded/destroyed areas white

The proposals are based on a stone monument in low relief, and different shades of grey may be introduced to represent different levels of background (as on e.g. Yaxchilan Lintel 14), similar to how the density of stippling was used in the past. The same recommendation may apply for tracing erosion or damage to the relief ground.

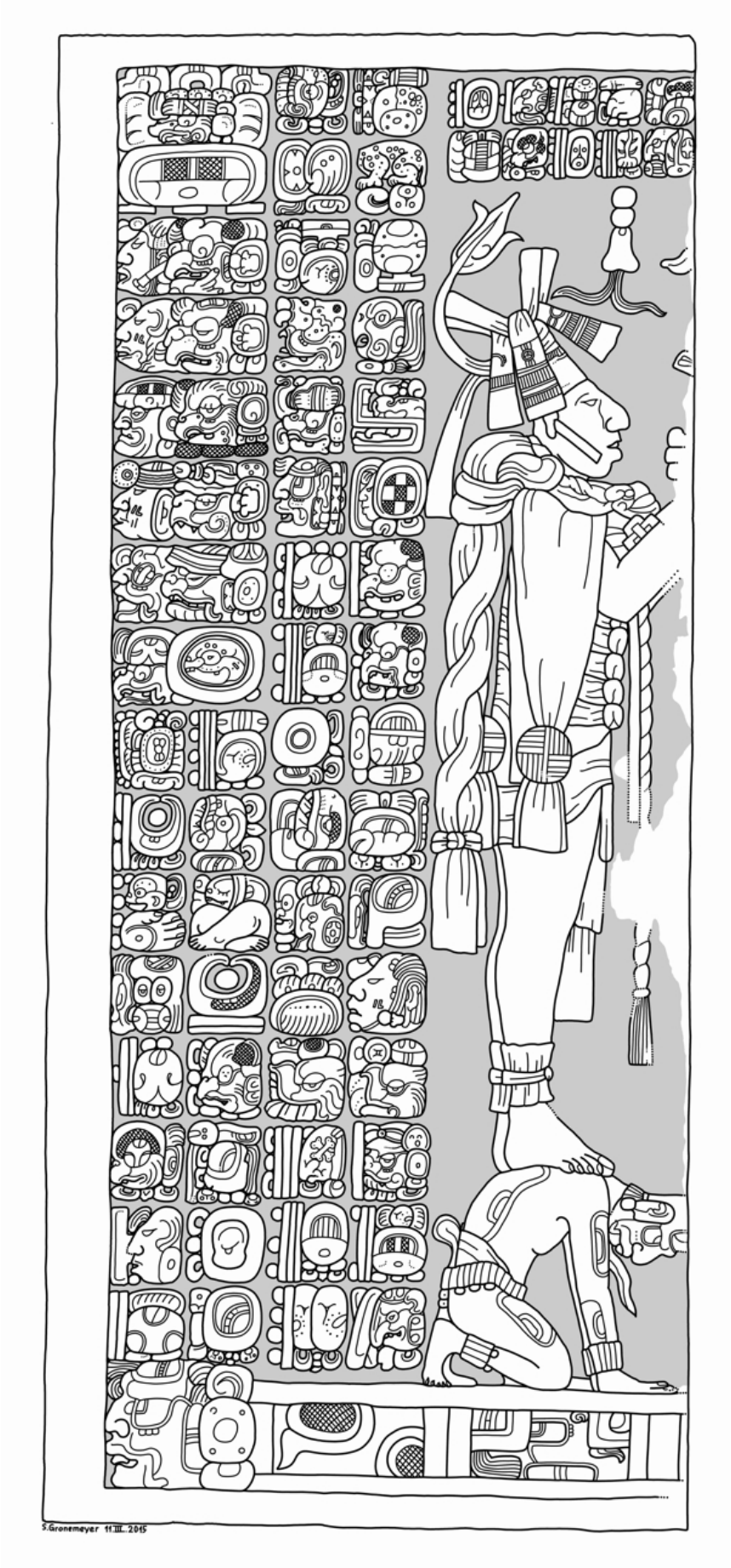

**Figure 3. Final Drawing of the Palenque Tablet of the Sun – Drawing by Sven Gronemeyer, 2015**

## Summary

The scanning and subsequent mesh rendering revealed that the fibre glass replica still yields a considerable level of detail that may initially not be seen on the actual physical object (partly because of the paint coating). A comparison with existing line drawings made from the original object now in the *Museo Nacional de Antropología* in Mexico City shows great similarities, but also reveals features previously not recognised by other artists.

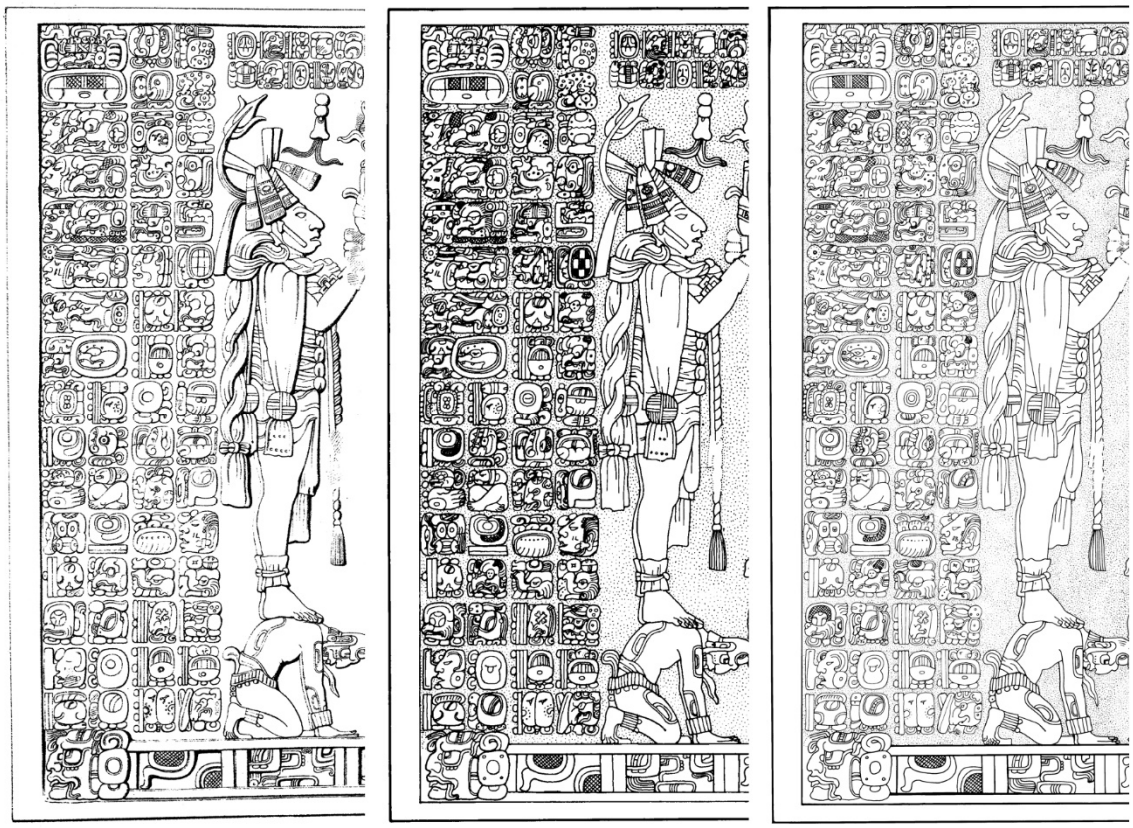

**Figure 4. Comparison between previous drawings – left: Drawing by Annie Hunter (Maudslay 1889: pl. 88), center: Drawing by Linda Schele (Schele 1976: fig. 12), right: Drawing by Merle Greene Robertson (Robertson 1991: fig. 95)**

One example is the correction of a grapheme that appears twice on the monument and in block I1 in the secondary text on the left slab. While previous artists rendered the collocation as **ko-bu-yi**, a close inspection of the scan reveals **ju-bu-yi**, which is of course the spelling of the *jub-uy-i* mediopassive "it gets down", as already analysed in the past, based on the context (e.g. Stuart 2006: 171).

The advantages of a detailed, isometric rendering of a 3D scan can be seen in the direct comparison between a photo from a plaster cast (Maudslay 1889: pl. 87) and a Lambertian radiance scaling rendering of the fibre glass replica from the same mold (Figure 5).

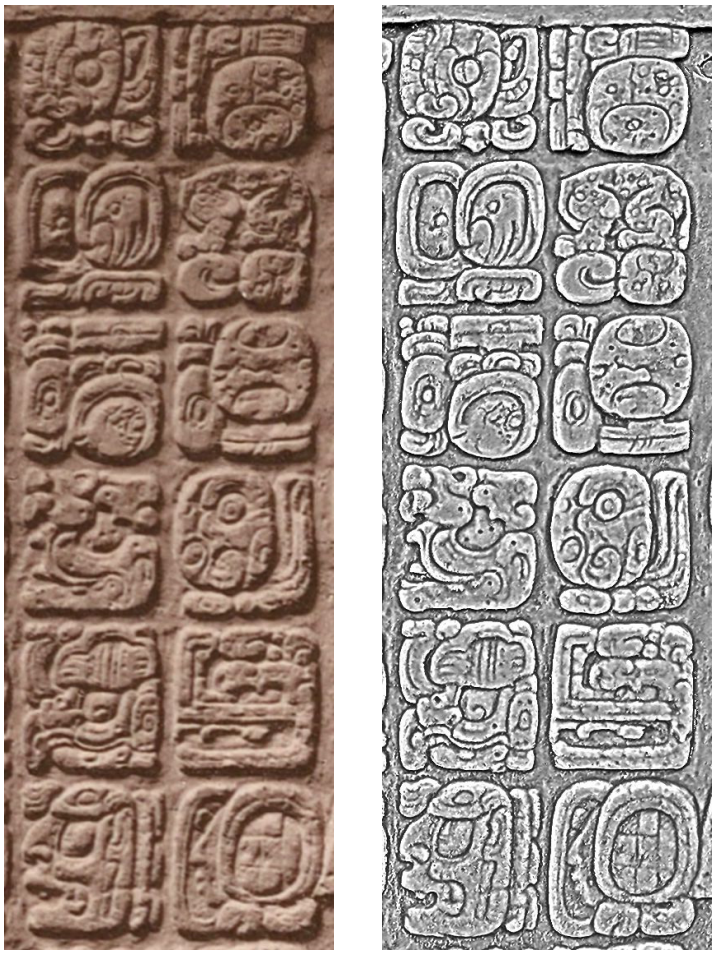

**Figure 5. Comparison between photo and 3D scan, blocks C1-D6**

In contrast to the photo, the rendering is matte and shows no shadows. Together with the contour highlighting, it allows a more precise tracing of the carved outlines in the drawing process. In fact, the radiance scaling of the scan of the cast also led to a new reading and interpretation (Wagner, Gronemeyer & Prager 2015) in a crucial passage of the text.

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