



3-D scanning and production of accurate form-fitting support cradles for fossils using CNC milling technology (Computerized Numerical Control technique): a project with the Geiseltal Collection

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1. The Geiseltal Collection

The Eocene fossils from Geiseltal (German for Geisel Valley) were found ca. 20 km south of the city of Halle (Saale) in central Germany. These fossils are unique due to atypical preservation within layers of brown coal (lignite), as opposed to above or below such layers. Fossilization of plants and animals within lignite was only possible at Geiseltal due to influx of calcareous waters that acted to neutralize the humic acids that result from lignite formation (HAUBOLD & HELLMUND, 1998). The fossil site represents a former marsh or swamp area. Lignite mining ceased in this region in 1993, but decades of fossil collecting have resulted in roughly 50,000 specimens, housed at the Geiseltal Collection in Halle (Saale). 125 different vertebrate species have been recognized within this collection, including 50 original descriptions with Geiseltal specimens serving as type material.

In recognition of the collection's unique value, the Geiseltal fossils were registered in 2012 as a collection of national cultural heritage by the authority for cultural property protection in Germany (Kulturgut Schutz Deutschland).



loan transport and its associated risk of damage. This digital method of scanning is non-destructive and further reduces the risk of mechanical and chemical damage associated with conventional molding methods.

2. Conservation and Digitization

Although well preserved, many of the Geiseltal fossils are very delicate and are easily damaged. An initial step toward fossil conservation is to digitize specimens using a 3D scanner. A record is then created of the initial status of the fossil (at the time of scanning) and can be used later as a reference to determine if the specimen is degrading over time. Thus any issues can be addressed before they worsen. Following digitization, with the help of Computerized Numerical Control (CNC) milling technology, digital files can be used to create form-fitting support cradles for fossil specimens. In addition, digital files can be made available internationally to researchers, potentially removing the need for specimen

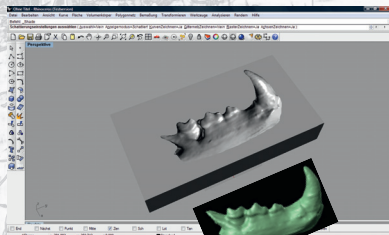


„Urpferd“, Propalaeotherium isselmanni

We present here the methods we have used to create custom-designed support cradles that are shaped to conform to the unique structure of each individual fossil. We begin with the first step of digitizing with a 3D scanner.

3. Scanning

Mobile hand-held 3D scanners can be used to quickly and accurately digitize complicated surfaces, including undercuts, in one single operation. Two different 3D hand-held optical scanners were tested: the REVscan produced by Creaform and the Artec Eva scanner produced by RSI 3D-Systems. Both systems were able to produce high quality digital surfaces.



Post-processing of the 3D data

Although Geiseltal fossils are very dark in color, neither machine had trouble producing the digital surfaces. Ultimately the Artec Eva scanner was chosen because it was easier to handle.

4. Data Processing and 3D Printing

The 3D surface data from the scanner requires further processing with a 3D modeling program, such as netfabb. The software can create a virtual 3D negative impression of the digital object with the help of boolean operation. The 3D digital file of the negative impression can then be read by the control software for a CNC milling machine, which then calculates the 3-axis route needed for the step-motors. A CNC portal milling machine table works well for printing the negative impressions from panels of polyethylene foam. The method works best when at least one dimension of the



STL files of the scanned Fossil block

object is 10 cm or less. Most Geiseltal fossils fall well within this 10 cm range for optimal working height. The cost of a CNC portal milling machine is 5,000 – 10,000 Euro (6,400 – 13,000 USD).

5. Foam Material

The plastic products marketed as Neopolen and Ethafoam are physically-formed polyethylene foam. These products contain a small amount of additives, which occur naturally and do not produce harmful exhalates such as acids. The material is produced in panels of varying thickness and hardness. The material is light-weight, resists moisture, and resists aging.



Neopolen Tray for Geiseltalfossilien

6. Conclusion

The method described above uses age-resistant, exhalate-free plastic material to safely store fossil specimens. Formerly this method would have been performed manually, but with the advent of affordable 3D scanners and 3D printing CNC milling machines, this can be done more efficiently, accurately, and with less risk of damage to the specimen. This digitization method avoids potential damage from physical or chemical stress caused by traditional methods of molding fossil specimens. The printed support cradles conform directly to the specimen, supporting all surfaces at proper angles for safe long-term storage of fragile fossils. Support cradles also create a safe means for moving fossils within the collections, and prevent specimens from sliding on the wood and box surfaces when opening specimen drawers and cabinets.

Literature

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