



3Düwelsteene - A website for the 3D visualization of the megalithic passage grave Düwelsteene near Heiden in Westphalia, Germany

The Düwelsteene, one of the southernmost sites of a megalithic tomb of the Funnel Beaker culture in Westphalia, western Germany, has been a place of interest for archaeological research since the early modern period and are now the foundation for new digital research methods. This megalithic tomb holds special interest for a study project because of its reconstruction history. The Düwelsteene is a restored archaeological structure and the current positioning of the megaliths dates to 1932. At that time the megalithic tomb was restored and the stones that had been in situ were relocated to recreate the structure as it was believed to have been in antiquity.

As part of a master's thesis, this study compared the extensive impact that such an intrusive restoration had, in contrast to the contact-less method of virtual reconstructions. By integrating the citizen science project, using digital research methods and creating virtual reconstructions, the advantages and disadvantages of digital reconstructions and public outreach in archaeology were examined.

Collecting old photographs through a citizen science project in the region of the Düwelsteene, allowed the virtual reconstruction of the megalithic tomb from before the tangible restoration in 1932 with the open source software Blender. This virtual reconstruction also provided more informative sources for the creation of a digital reconstruction of the original Düwelsteene structure of around 3000 BC. The initiative started as a top-down citizen science project engaging the public to collect data. But it resulted in a community driven, bottom-up project with the subsequent reconstructions being built with open source programs and shared online.

The website to display the virtual reconstructions and 3D model of the current structure was built with Bootstrap and is hosted on GitHub. The advantage of GitHub is the integrated version control and open access to the data and code used for the website. To display the virtual models, the 3D viewer 3DHOP (3D Heritage Online Presenter) was used. The basic 3DHOP viewer has a number of features already integrated, which are helpful for displaying cultural heritage content. It is possible to change the lighting, zoom in and out of the model and measure the 3D models in the viewer. The 3D objects can be cut into sections to see inside and a basic code for annotations is provided. For this website even more features were built, like the visualisation of the certainty with which the reconstructed megaliths were positioned. On the website it is also possible to toggle the reconstructed hill on and off and view the metadata for each model.

The digital reconstruction work of the Düwelsteene would have been much harder without the photographs collected through the citizen science project. Needing to rely on data from outside of archaeology shows the impact of hands-on restoration work on tangible cultural heritage sites, especially when such work is not documented enough. This also

emphasises the benefits of virtual reconstructions, where hypotheses can be tested and comparisons between structures are much easier implemented.

Using digital methods and three-dimensional models can help visualise the changes and lead on to new findings. Especially with many archaeological sites presently being excavated and documented using digital methods in surveys, it is much easier to use the resulting data for further research. Even without prior excavation or documentation work, many cultural heritage sites can easily be turned into digital models due to new image-based modelling techniques, that don't require time consuming methods and expensive equipment.

For this project digital archaeological research and virtual visualisations was combined to also benefit the general public. It was demonstrated, that projects using 3D reconstruction modelling as a research environment can be published and help spread awareness and information on cultural heritage sites to the general public. Most programs and software that were used, were open-source. The publication of the 3D models on the website can be tracked and downloaded, which means the workflow and features can be used and applied to other cultural heritage projects.

The website: <https://3duewelsteene.github.io>
(English Version: https://3duewelsteene.github.io/index_en.html)

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Data, scripts, code, and supplementary information availability:

The GitHub repository: <https://github.com/3DUewelsteene/3DUewelsteene.github.io>