1 Introduction

The "Sky Disc of Nebra" is a bronze disc, 32 centimeters in diameter, with gold-leaf appliques representing the sun, moon, stars and a ship (Fig.1). It caused a worldwide sensation when the 3,600 year old Sky Disc, the world's oldest image of the cosmos was brought to the attention of the public in 2002, having been discovered in the state of Saxony Anhalt near the village of Nebra two years earlier. The Sky Disc is considered a key find not only for archaeology but also for astronomy and the history of religion.

The disc was found on the summit of the Mittelberg hill, near the wooded area of Nebra in eastern Germany, together with valuable swords, jewelry and tools. The restored disc is the center piece of an exciting Bronze Age show of Europe, which started in Halle in October 2004 (DEUTSCHE WELLE, 2004). Because of the great success this presentation will travel through out Europe.
This paper intends to describe how GIS-based landscape visualization could help the interpretation of the bronze disc. Following the original interpretation by Professor Dr. Schlosser from Ruhr University in Bochum, the astronomic representation shows the seven star Pleiades constellation which was of importance in antiquity. That the Pleiades is positioned beside the crescent moon in a constellation would mean that lunar eclipses were observed by the prehistoric people and complex knowledge of celestial laws existed. The two gold bands on the edge of the disc, which were applied later, are representations of the horizons. The lengths of the two gold bands represent exactly an angle of 82.5° - this is precisely the arc of the sun’s traverse from sunrise to sunset on 21 June and 21 December in Central Germany (LDA 2005).

According to Harald Meller, (MELLER, 2004a) the Mittelberg Hills, where the disc was found, had a clear view of distant landmarks in circa 1600 BC. The Mittelberg near Nebra seems also to display an astronomical meaning. According to Professor Schlosser, viewing from here on summer solstice, the sun descends behind the Brocken, the most important mountain in the Harz (Fig. 3). Orient the northern end of the disk’s western band with the Brocken and the opposite end of the band aligns with sunset on winter solstice. Frost
Interpreting the Sky Disc of Nebra using 3D GIS

According to the current interpretation, the sky disc had to be held up above the head and interpreted by looking up (at the sky). This, when compared to Figure 3’s upside perspective, reverses the vistas to Brocken and Kyffhäuser. None of the interpreted vistas are possible today because the top of the Mittelberg where the disc was buried for over 3,600 years is now heavily forested. Furthermore, the forest is protected as a potential Flora Fauna Habitat (FFH). A clearing in order to reconstruct the hypothesized scattered tree vegetation of the Bronze Age or any other type of opening at the forest to establish these ancient vistas cannot be considered because of the FFH protection status of the forest. The key question, “had these vistas ever been possible given the terrain and changing land use”, is a perfect one to be answered for a GIS-based landscape visualization. Additionally, this visualization can help to optimize the maximum height of an observation tower for interpretation and could be the basis of a Virtual Reality (VR) interpretation environment.

### 2 Project Description

With today’s technological opportunities in landscape visualization, the relevant question is no longer “What is possible?”, but rather “What do we want to achieve?” (EGGER, GEIER, MUHAR 2002). Having this in mind, the most effective way to answer this questions had to be found. Answers for the theoretical support of the vistas themselves, for the minimum effective height for an interpretation tower overlooking the existing forest and for ways of using GIS-based VR technologies as a part of multimedia visitor information had to be found.

The area where the Sky Disc of Nebra was found is situated on the 252 meter high Mittelberg in the Ziegelrodaer Forest near Wangen, a village close to Nebra along the small, romantic river Unstrut and its vineyards. (s. Fig.2 ). Based on the astronomic interpretation of the disc, the historical vistas to Kyffhäuser, Brocken and Petersberg had to be analyzed. Additionally, the effect of the change of land use at the time of the disc’s use ca. 1,600 BC and that of today had to be addressed.

### 2.1. Developing Scenarios

In order to create an image of a real landscape, the elements terrain, vegetation, animals and humans, water, built structures, and atmosphere and light are decisive. However, depending on the questions posed and the required level of detail, not all elements must be addressed (LANGE 2002). According to LANGE, the elements terrain, vegetation, water and built structures were selected for the visibility analysis of the long distance views. In order to reconstruct the historic conditions, three scenarios which included the astronomic interpretations, as well the height of the observation tower, were developed.

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2.2 Visibility Analysis

Decisive for the visibility analysis was, of course, the use of a digital terrain model. The area of research encompassed approximately one-third of the area of the state of Saxony Anhalt as well as parts of Thuringen (Kyffhäuser) or a total of 95 by 55 kilometers. For this reason, the radar data of the Shuttle Radar Topography Mission (SRTM) from 11 February, 2000 with a raster width of 90 m., was used for the digital terrain model.

This data is easily available, free of charge and offer a very interesting alternative for creating terrain models for larger areas (Ouiel 2003).
Information about the precision of the different SRTM DTED formats is provided by WAGNER, 2003. To determine the current land use, the available Biotope and Land Use Type Mapping of the State of Saxony Anhalt, which was interpreted from aerial photographs 1992/1993, was used. All possible landscape elements with a height of at least 2 meters as well as bodies of water were considered for cartographic purposes. Furthermore, the use of different coordinate systems of data from various sources made it necessary to transfer all GIS data into one reference system.

Using the 3D analysis by ESRI, the described scenarios of the vista with the function Line-of-Sight between Mittelberg and Kyffhäuser, Brocken and Petersberg and the cross
sections through the terrain of these three vistas were calculated. The graphics show the visibility possibilities between the described hills (see Fig. 7 to 11).

Fig. 9 + 10: Visibility map and visualization of vista Mittelberg- Brocken

Fig. 11: Visibility section Mittelberg- Brocken

3 Interim Results

The first analyses using the terrain model driven by the 90 meter raster data have shown that the visibility between Mittelberg and the three hills 35 to 90 kilometer meter in distance had very likely been possible. Furthermore, the minimum effective height for the visitor tower, as estimated according to the forest conditions on the Mittelberg, was proven correct given the precision of the terrain model.

Of course, there are uncertainties in regards to the land cover of the area at the time of the Sky Disc's origins 3600 years ago. In general it has been shown that visibility analysis for long distance views can be carried out using free of charge 90 meter radar driven digital terrain data, and available land cover information utilizing standard GIS technology. For long distance, the level of detail is sufficient. For the area of close range visibility and for in-depth analysis of critical areas, greater terrain precision is necessary. The size of the area
where more precise elevation data is needed, can easily be found using the rough terrain analysis, saving time and money.

4 Future Directions

For the foreground analysis of the vistas from the Mittelberg, the utilization of a more detailed digital terrain model with precise horizontal accuracy such as that available from the state surveying office, is necessary. Furthermore, it would be exciting to cooperate with astronomers in order to find ways to "georeference" the constellations of the Sky Disc. Another field of scientific interest is the remodeling of the changing vegetation in the Bronze Age based on the far reaching archeological analyses that were carried out to determine the age of the findings at the Mittelberg. All these scenarios could be used for the basis of a Virtual Reality (VR) interpretation environment.

5 References


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