# Making your Own Sky Disk

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## Abstract

The sky disk of Nebra is the earliest representation of the night sky, which has considerable implications on archeo-astronomy, history of religion, archeology and history of metallurgy and of technology. It was dated to approximately 1600 BC on the basis of bronze artifacts found in same hoard in Nebra, Eastern Germany. According to the scientific and astronomical examinations the current results concerning the manufacture, the use and the importance of the find will be given.

In the second part several group activities with students are described. Each participant of the workshop designs his own astronomical sky disk for a chosen location. The length of its lateral arcs depends on the horizon region which is accessible to the sun over the year. By the use of software or demonstrators of yearly solar motion the azimuth regions are determined. The rest depends on the artificial skill of the builder: an important astronomical event like a sun or moon eclipse can be presented or the historical situation is presented or the brightest stars of the starry night due to different seasons are shown.

## INTRODUCTION

The Nebra sky disk is dated to 1600 BC and attributed to a site at Nebra, Saxony-Anhalt in Germany. It is a bronze disk of 31.8 cm diameter, wearing a blue-green patina and inlaid with gold symbols interpreted by experts as sun or full moon, a lunar crescent, 32 stars (including a cluster interpreted as the Plejades), two golden arcs of 82.7° each, and a short arc in between the two big ones, interpreted as a sun boat with many oars. It has been associated with the Bronze Age culture.

In 1999 three illegal treasure hunters have dug using a metal detector this significant archaeological find together with other remains (two bronze swords, two hatches, a chisel and fragments of spiral bracelets). The discovery site is a prehistoric enclosure encircling the top of the 252 m hill called Mittelberg in the Ziegelroda Forest, near the town Nebra in Saxony-Anhalt, Germany. The surrounding area is known to have been settled since the Neolithic. The Ziegelroda forest is said to contain more than 1000 barrows. The disk appeared on the international antiquities market in 2001. Following a police operation in Basel, Switzerland, the disk was acquired by the State Museum for Prehistory in Halle, Germany.

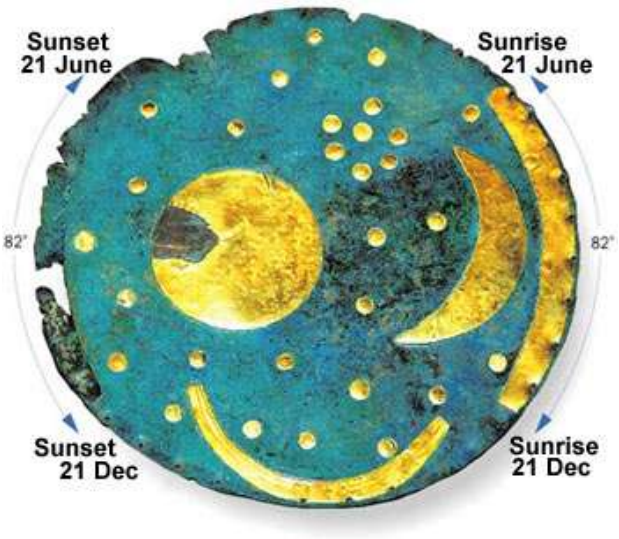


Figure1. Nebra disk

## SCIENTIFIC INVESTIGATIONS

The enclosure was orientated in such a way that the sun seems to set every equinox behind the Brocken, the highest peak of the famous Harz Mountains. The green layer of corrosion that had formed on its surface does not mean the disc was genuine in any case. But the giant corrosion crystals on the surface were much bigger than anything a faker could produce. The more precise dating of the Nebra disk, however, depended upon the accompanying hoard finds, the Bronze Age weapons. Because the disc was made of metal it was not possible to use the most accurate technique, carbon dating. So the scientists turned to another method called associate dating. The disc has been found in the same hole and had the same soil level as two swords of a very special design. By comparing them with similar objects that had been successfully carbon dated. Radiocarbon dating of a birch bark particle found on one of the swords from between 1600 to 1560 BC confirmed this estimate.

According to an analysis of trace elements by synchrotron radiation X-ray fluorescence (XRF) to analyse all gold inlays the copper of the disc originated at Mittelberg in the Austrian Alps, while the gold is from the Carpathian Mountains. The technology for producing such inlays is well known in Mycenae (Greece).


Figure 2. Manufacture of the Nebra Disk

The disk was developed in four stages:

1. Initially the disk had 32 small gold circles with a large crescent-shaped plate attached. The full circle is interpreted as either the Sun or the full Moon (or the Sun or the Moon undergoing eclipse), and the dots are stars with the cluster of seven points representing the Plejades.
2. At some later date, two arcs on the edge (constructed from gold of a different origin, detected by its chemical impurities) were added. In order to attach these arcs, one star was moved from the left side towards the centre of the disk and two on the right were covered over, so that thirty remain. The angular span of the golden segments (one is missing now) can be interpreted as the annual solar swing between the positions of sunset and sunrise at summer and winter solstice. The angle of 82.7° each is exactly the distance between the northernmost and southernmost solsticial points of the Nebra Area. As the arcs relate in this step of development to solar phenomena, the interpretation of the full circle may change at the end. The circle may represent later on the Sun and not on the moon.
3. The final addition was the short arc in between the two big ones again made of gold from a different origin. The orientation in which it was found supports the imagination of a "sun barge" travelling between sunset and sunrise at night.
4. Before the time the disk was enclosed in the hoard it also had thirty-nine or forty holes punched out around its edge. The reason is unknown.

The use of the disk remains a mystery. Were the horizon arcs applied for actual measurements? Was it a teaching tool for novices at the observatory? Was it a pure religious item?

Students can develop their ideas, speculations and knowledge at this stage. It is useful to strengthen their opinions in two directions: Possibly the beautiful disk was a scientific astronomical instrument as well as an item of religious significance. To lift the quality of the discussions further input is needed. From the ongoing studies of the disk, the evacuation and further historical studies more details are to be deciphered.

The culture of people from the Bronze Era got lost in the course of time and the only material evidence of their existence is saved at places where settlements, graves and treasure hoards used to be. Scientists claim that it is impossible to assume which language they used. The traditional classical world in Mediterranean, in North Africa, or in the Middle East got cultures which developed monumental architecture at the same time. With civilisation in those regions came astronomy and philosophy. By the Bronze Age writing is used in every area of Egyptian culture. They used to record religious texts in temples and in tombs. Their ideas and values could be passed on from generation to generation until now. In the heart of northern Europe it seamed to be a completely different story: no great cities, no early forms of writing, none signs of philosophy. Instead crude lumps of rocks were arranged in to mystifying monuments. The remains such as spears, axes and swords founded conventional image for Bronze Age Europe as a place of darkness and savagery.

## ASTRONOMICAL INTERPRETATION

This kind of investigations was done by Professor Schlosser at Bochum University in Germany. The mystery dots on the sky disk seemed to be stars. It is not clear if they were random images or were the ancient people advanced enough to have mapped the stars. The 25 stars besides the seven stars of the cluster were distributed across most of the disk by computer experiments to see if they would match with the stars in the night sky. But there were no matches. A true random distribution with Poisson statistics would look much clumpier[3]. One actively tried to avoid the formation of any pattern. These stars it seemed were just decorations.

Seven of the stars form a tight pattern. Preference was given to the interpretation Plejades. The cluster was important in the ancient civilisations of Mesopotamia, Egypt and Greece. It appeared in March and disappeared in October, vital dates for Bronze Age farmers. From Geek writers (Homer, Hesiod) we know that the Plejades were used as an agricultural marker, so that the farmer knew when they should do certain agricultural activities. Professor Schlosser compared the oldest images of the cluster which he could find on tablets and scrolls from the East. The Plejades were drawn with just seven stars in a pattern just like on the disk. Mapping the stars, understanding their movements and documenting this knowledge was a skill that was developed in thousands of years. Egyptian and Babylonian scholars drew their important constellations as animals. But realistic star images did not appear before 1400 BC in Egypt. These had always been considered to be the oldest known to man. Using the swords we can securely date the disk to 1600 BC. This date made the Nebra disk the oldest accurate picture of the night sky in human history, two hundred years older than the oldest images found in Egypt. The cultural flow went from the north to the south. It started about 5000 BC, 2000 years before the pyramids, and 3000 years before the sky disk. A strong direct clue to authenticity of the Sky Disk is given by the geographical location.

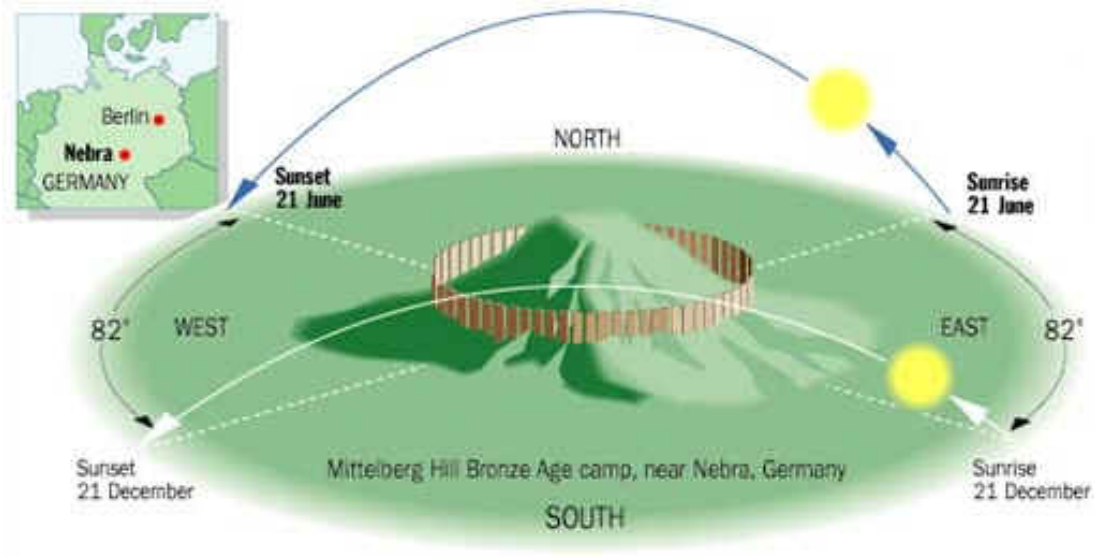


Figure 3. Mittelberg site

The Mittelberg hill was enclosed by a circular bank and ditch of 100 m diameter. The sunset on solstice occurs behind the legendary Brocken Mountain and on May 1 sun sets behind the hills of the "Kyffhäuser Wald". From the earliest times ancient monuments have been aligned to mark the high summer sunset and the low winter sunset. The precise angle between these horizon points varies from place to place. Further north it would be ninety degrees, to the south it is just seventy degrees. The golden horizon bands on the disk are the eastern and western horizon sectors. Its angle of 82° exactly covers the swing of the sun between summer and winter for the specific latitude of Nebra. A slightly asymmetry of these arcs with respect to the centre of the disk makes it possible that the upper solar limb was observed.)

The sky disk has developed from a stellar point of view to a solar point by adding the two azimuth arcs and by changing the location of three stars. This could be done during 150 years. So the first design of the sky disk can be before 1750 BC. Great experience of the farmers transferred from one generation to the other is needed to find the correct length of the arcs and the stellar positions of the Plejades and moon during the year. The earliest hints to common knowledge about the stars in Midst-Europe go back more than three thousands of years before the sky disk. Although these earliest Neolith agriculturists most likely measured only the sun's movements, over thousands of years they came to quantify the position of stars and especially of the Plejades. All over the world the arrival of this cluster in the night sky showed that it was time to start bringing in the harvest. In the first period the Nebra disk seemed to be a calculation tool used to determine planting and harvest times.

An investigation of the visibilities of the Plejades for the location Mittelberg in 1600 BC results that only their last evening visibility (heliacal setting in March 10) and their first morning setting (October 17) in the west were of calendar use in Early Bronze Age. The Plejades were found then near the ecliptic in those parts which are the domain of the young crescent shortly after new moon (March) and of the full moon (October). This may explain the composition of the crescent and round object and the picture of the Plejades in the middle. These dates describe very well begin and end of the agricultural year for the finding region. Lithuanian farmers observe until now the last evening visibility and the first morning setting of the Plejades as agricultural signs.

Beside this mainstream interpretation ('rural year') which is as speculative as other opinions. The interpretation of Andis Kaulis relies on the empty sun boat. In his opinion the sky disk records on the solar eclipse of April 16, 1699 BC, which took place next to the Plejades at sunrise near the point of vernal equinox, together with a conjunction of the planets Mercury, Mars and Venus as "bridesmaids for the wedding of the Sun and the Moon". Then the Nebra disk presents the sky during the day and not at night. The sun could just as well be the full moon, while the crescent moon could just as well be a partial eclipse of the moon. It seems that these objects prohibit an exact interpretation. Both heavenly objects often have passed by the Plejades in Bronze Age.

The Sky Disk has religious relevance too. The golden bow, surrounded by small notches etched in the plate, represents a solar boat with oars. It appears to have no calendar function but probably demonstrates the nightly transit of the sun from west to east. The

northern European Cultures were familiar to the concept of a solar boat. There is no need to adopt that the theme is borrowed from Egypt or the Mediterranean.

The Sun chariot of Trundholm is a late Nordic bronze artefact. (1400 BC to 1300 BC). A horse stands on a bronze rod supported by four wheels. The rod below the horse is connected to the sun disk which is supported by two wheels. The sun is drawn across the heavens from East to West during the day, presenting its bright side to the Earth and returns from West to East during the night, when the dark side is being presented to the Earth.

Figure 4. The Sun chariot of Trundholm

Legends and rites of the Bronze Age in North and Central Northern Europe can also help us. A Baltic folk song known as Latvian “Dainas” relates that the Sun falls into a golden boat when it disappears at sunset in the evening:

| | |
|---|---|
| “Noiet Saule vakarä, | <The Sun goes down in the evening.> |
| Iekrit zelta lainina | <And falls into a golden boat;> |
| Uzlec Saule no ritina | <When the Sun rises again in the morning> |
| Paliek laiva ligojot | <The boat remains floating on the water> ” |

The sun, the moon, the solstices, the sun ship, and the Plejades are all part of a complex European wide belief system. The Nebra disk has brought all these symbols together and is unique in many aspects. Men in Central Europe traditionally seen as primitive and uncivilised, without a written language make visible their complex religion. The hoard finds, as deposits of metal, were distributed over Europe like a net. These findings in Central Germany from the Bronze Age filled with axes, swords; sickles and jewellery offer a fine impression of the same religious phenomenon.

## ACTIVITIES

### 1. Statistical Experiments

Statistical research strengthens the opinion that the remaining 25 gold plates are distributed as random as possible. Give the students a sheet of paper on which inside a surrounding circle the full moon, the lunar crescent and the lower small arc are marked. The task is to draw 25 dots in the remaining area avoiding the formation of any pattern. Compare the results with a random distribution with Poisson statistics. You can also use the results published in Schlosser. The distributions generated by the computer look much clumpier. Some patterns look like the well known constellations like Cassiopeia or Big Dipper. Students will produce patterns similar to the distribution of the disk.

## 2. Sunset and sunrise positions – a long term activity or a computer research

Students are to observe where on their local horizon the sun sets over a long period of time- the longer the better. Their records become a horizon calendar, similar to those created across Middle America, Europe, Middle East and Africa which were used as calendar for agriculture, religion, or migration. One of the best known examples is Stonehenge, an ancient collection of monoliths in Southern England in the late Neolithic Age (3000 BC - 2000 BC), whereas the Sky Disk of Nebra has probably be used from 2100 BC to 1600 BC.

Creating a complete horizon calendar would take a full year, but this activity is still useful even if carried out 2-3 months. The sunset position does change fastest during autumn and spring, and less rapidly around summer and winter solstices. You can create a horizon calendar for the class on the wall. The students bring back their observations to the class and check their data changing with time on the map. Another method is to make observations from a special location and to establish proper compass points to help the observer. They will measure the azimuth, defined as angle around the horizon due to North. North has the azimuth 0°, East 90°, South 180°, West 270°. If the sunset were in the Southwest, the azimuth would be 225°.

Instead of performing a long-time job you can use the demonstrator of the solar motion for the determination of the daily sun's azimuth or the angle of the yearly solar swing. This small, hand-held device was created out of heavy card stock in the past EAAE-Summer Schools. A paper fastener representing the sun glides over the month arm modelling accurately the changing position of the sun for any observer in the northern hemisphere. The daily path of the sun above the horizon disk is shown by twisting the month arm from East to West. On the horizon disk the azimuth of the local solar swing can be measured. Of course it is also useful to use a computer with astronomical "planetarium" software that can calculate the precise sunset positions: Summer Solstice, about June 21; Winter Solstice, about December 21; Spring Equinox, about March 21; and autumn equinox, about September 21.

## 3. Production of your Sky disk

Modelling a sky disk for your home depends on the function the disk should fulfil. Besides the interpretation given in this paper Audis Kaunis believes that the correct interpretation of the Sky Disk of Nebra is a question of evidence. In his opinion the disk records the solar eclipse of April 16, 1699 which took place near the Plejades at sunrise together with a near conjunction of three planets.

Students develop different ideas for their personal discs, e.g.:

1. Repeating the historical design for their home destination.
2. Using of the plate as star finder which helps them to locate major constellations visible at any time for any date or for a special season.
3. Presenting of a significant event in the past like a moon or a sun eclipse.

Their design should have as many coincidences with the original as possible. Some interpretations of the disk are more or less probable:

- The 32 gold buttons on the Sky disk are stars.
- The gold cluster represents the Plejades.
- The bows on the edge are horizon markers, marking the swing of the sun between summer and winter solstices.
- The smaller curved golden arc represents the sun arch.

Procedure

Prepare enough blue-green coloured cake plates made out of cardboard so that each student can make his own sky disk. Creating a sample will help them understand what the final product should look like. The centre of the disk and the directions North, South, East and West are to be determined. Due to the local latitude the solstices diagonals are calculated as explained in the preceding activity, and are drawn according to their azimuths with gold metallic acrylic mat paint. To cut and glue gold paper modelling the horizon arcs instead needs more skill. The filled small golden circles for the stars are stamped by wet coloured round objects like the ends of sticks.

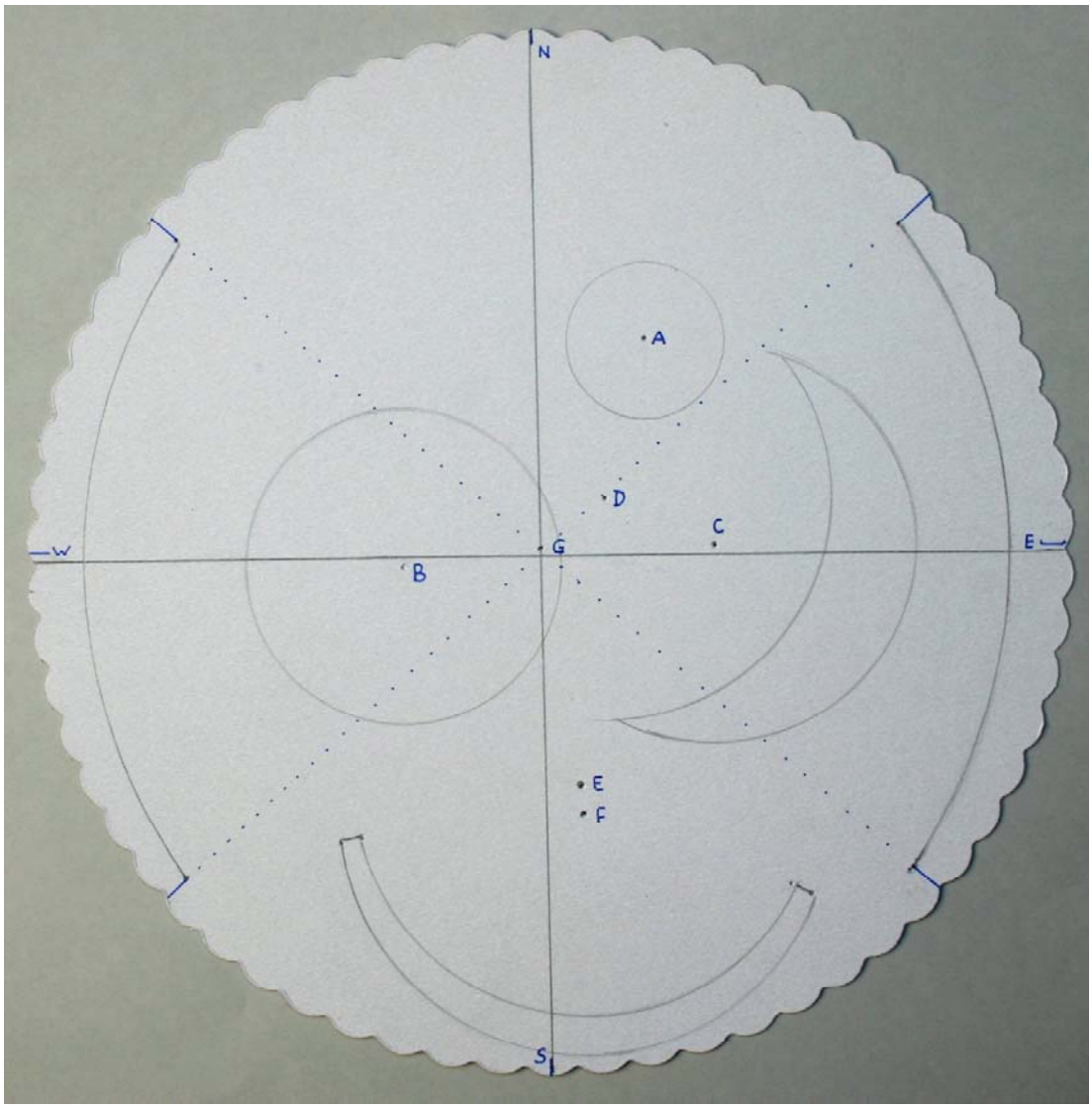


Figure 5. Map of the elements drawn on a paper plate

Special attendance is needed for the position of the objects like stars, sun and moon. Hold the disc over your head so that the "North" designation is pointing north. The objects showing on the disk are those that can be seen overhead at the time and date chosen. The edge represents the horizon. Stars near the edge of the plate are low on the horizon. Depending on the concept you are performing, the centre of the plate is the point directly overhead when you look up in the night sky. This point is called the zenith. Stars near the centre will be high overhead when you are observing.

The students are given the coordinates of the centre and the sizes of the original symbols which they want to use. They have to adapt the sizes to the dimension of their disks.

| *Symbol* | *Centre in (x / y)* | *Radius (cm)* | *Angle* |
|---|---|---|---|
| Plejades | A (3,21 / 6,65) | 2,54 | |
| Sun | B (-4,21 / -0,22) | 4,88 | |
| Outer crescent | C (5,20 / 0,33) | 6,07 | |
| Inner crescent | D (1,99 / 1,77) | 6,83 | |
| Boat inner circle | E (1,11 / -6,98) | 6,82 | |
| Boat outer circle | F (1,11 / -7,53) | 7,51 | |
| Solstice diagonals for the Nebra Disk | G (0 / 0,31) | Diameter 31,8 | Coordinates Nebra: 51°17'02" N, 11°31'12" E Summer Winter **82,7°** |

Table 1. Sizes of the circular symbols on the original

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