



The Megalithic Passage Tomb at Newgrange was built about 3200 BC. The tomb is about 250-feet in diameter and 44-feet high. It was discovered in 1699 and was been excavated and rebuilt between 1962 and 1975.

The kidney shaped mound covers an area of over one acre and is surrounded by 97 stones, some of which are richly decorated with megalithic art with solar motifs.

Once a year, at the winter solstice shines directly along the long passage into the chamber for about 17 minutes and illuminates the chamber floor. This alignment is too precise to be widely considered to be formed by chance. Professor M. J. O'Kelly was the first person in modern times to observe this event on December 21, 1967.

The sun enters the passage through a specially contrived opening, known as a roofbox, directly above the main entrance. Although solar alignments are not uncommon among passage graves, Newgrange is one of few to contain the additional roofbox feature. The alignment is such that although the roofbox is above the passage entrance, the light hits the floor of the inner chamber.

Today the first light enters about four minutes after sunrise, but calculations based on the precession of the Earth show that 5,000 years ago, first light would have entered exactly at sunrise. The solar alignment at Newgrange is very precise compared to similar phenomena at other passage graves in the Orkney Islands, off the coast of Scotland.

Outside the tomb, 12 out of the original estimated 38 large boulders up to 8-foot high form a ring of about 340-feet in diameter. The stone circle was built about 1000 years later than the original structure, dating probably from the Beaker period. The 58-foot long inner passage leads to a cruciform chamber. It is estimated that the construction of the Passage Tomb would have taken a work force of 300 laborers at least 20 years.



The Newgrange monument primarily comprises a large mound, built of alternating layers of earth and stones, with grass growing on top and a reconstructed facade of flattish white quartz stones studded at intervals with large rounded cobbles covering part of the circumference. The mound is 76 meters (250 ft) across and 12 meters (40 ft) high, and covers 0.4 hectares (one acre) of ground.

Within the mound is a chambered tomb passage, which can be accessed by an entrance on the south-eastern side of the monument. The passage stretches for 19 meters (60 ft), or about a third of the way through into the centre of the structure. At the end of the passage are three small chambers off a larger central chamber, with a high corbelled vault roof; this cruciform design is common in Irish passage tombs.

## Education Standards Satisfied by This Activity

(See Benchmarks for Science Literacy, Project 2061, AAAS)

### 1c – The Scientific Enterprise

**G6-8** “Important contributions to the advancement of science, mathematics and technology have been made by different kinds of people, in different cultures, at different times.

**G9-12** “The early Egyptian, Greek, Chinese, Hindu and Arabic cultures are responsible for many scientific and mathematical ideas and technological innovations.

### 2a – Patterns and Relationships

**G9-12** “Although mathematics began long ago in practical problems, it soon focused on abstractions from the material world, and then on even more abstract relationships among these abstractions.

### 3A - Technology and Science:

**G6-8** “Engineers, architects and others who engage in design and technology use scientific knowledge to solve practical problems. But they usually have to take human values and limitations into account as well.

### 4B – The Earth

**G6-8** “Because the Earth turns daily on an axis that is tilted relative to the plane of earth’s yearly orbit around the sun, sunlight falls more intensely on different parts of the Earth during the year. The difference in heating produces the planet’s seasons and weather patterns.

### 11B – Models

**G3-5** “Geometric figures, diagrams, and maps can be used to represent objects, events and processes in the real world although such representations can never be exact in every detail.

**Step 1** - Obtain a piece of graph paper and mark it at a convenient scale for your tomb. For example, for a modest tomb, a scale of 1 meter per cm should suffice. Draw a Cartesian coordinate grid with 1-cm divisions. The horizontal 'X-axis' will represent the east-west direction, the vertical 'Y-axis' will represent the geographic north-south axis.

**Step 2** - Create a tomb lay-out whose geometric center is at the origin of your coordinate grid.

**Step 3** - From the table below calculated for the latitude and longitude of Denver, Colorado, decide which event you want to encode into the architecture of your tomb. Note the azimuth angle. For other locations, use the sunrise / sunset calculator at <http://www.srrb.noaa.gov/highlights/sunrise/azel.html>

**Step 4** - With a protractor, draw a line through the center (origin) of your tomb with an angle equal to the azimuth of the event. Note, the azimuth angle begins at 0-degrees for North, and increases clockwise from east (+90 degrees), south (+180 degrees) and west (+270 degrees).

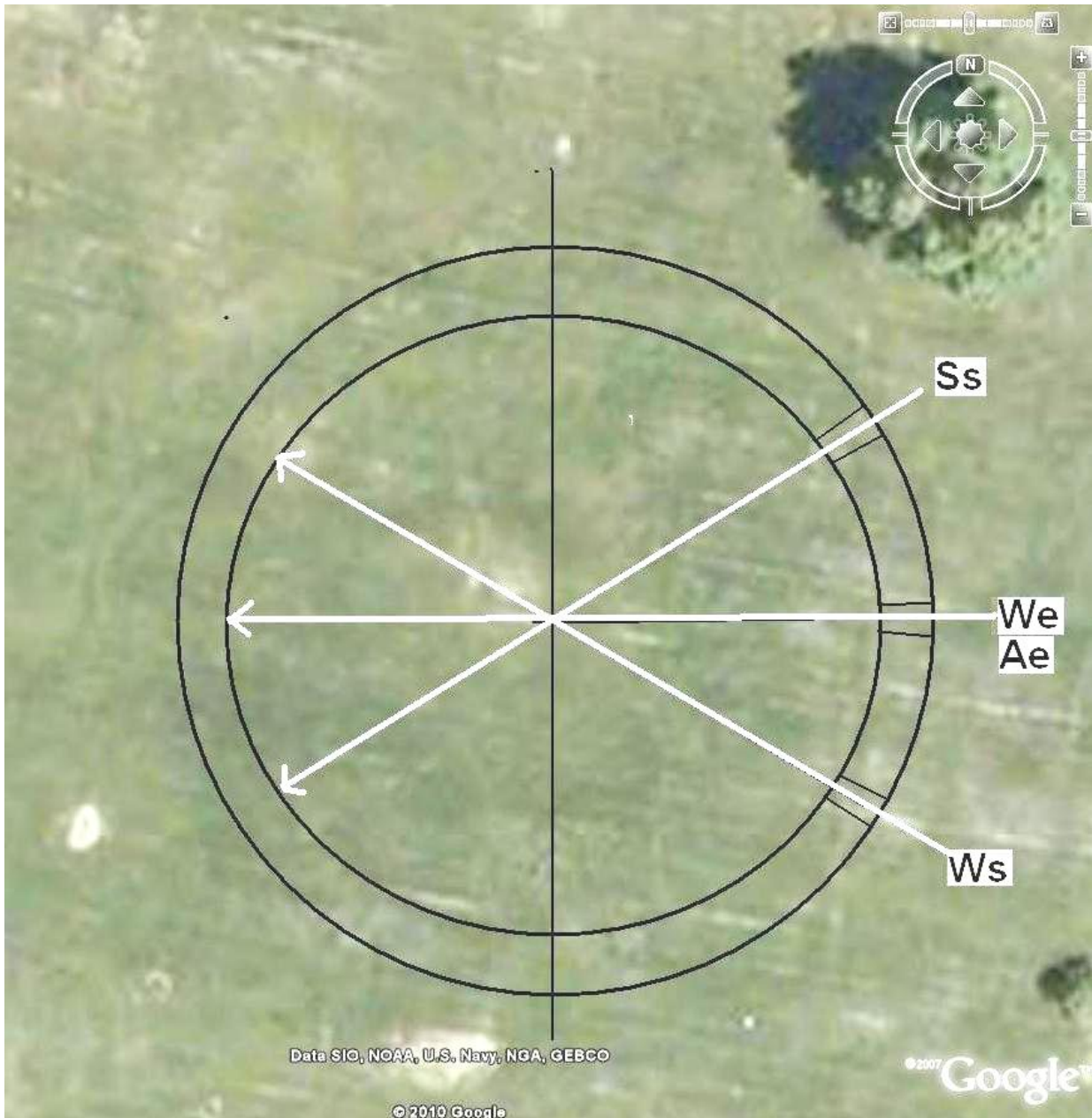
**Step 5** - Note with an arrow the viewing direction for the event along the line you drew in Step 4.

**Step 6** - In the wall that is located along the viewing axis between the center of the tomb and the event, cut a hole in the wall to let the light into the tomb. Note that if you want this alignment to work for 2000 years, you have to cut the window so that it has an angle of 2 degrees wide as viewed from the center of the tomb. Use your protractor to mark two lines on the tombs circumference that spans 2 degrees.

**Step 7** - On the opposite wall of the tomb from the window, create a memorable decoration that you want to illuminate when this event happens each year. You might want to consider a statue of yourself seated in a chair!

Sunrise Event	Azimuth (degrees)
Winter Solstice	121
Spring Equinox	89
Summer Solstice	57
Autumnal Equinox	89

Example of a tomb in Denver, Colorado showing all four alignments in the table:



The arrows point from the sunrise point on the horizon to the spot inside the tomb where the sunlight will fall after passing through the window in the eastern side of the tomb wall. A tree is shown in the upper right corner. The width of the image is about 80 meters. This particular scene is in the park near the Denver Museum of Science.