

ENGLISH TEXT

MAUREEN HINTZ INTERVIEW

Interview question n.1

(Hintz 1) My name is Maureen Hintz. I live in Utah, USA. Utah is located in what is referred to as the Mountain West, along the western edge of the Rocky Mountains.

(Hintz 2) I work at Utah Valley University, and you can see the mountains from my campus.

(Hintz 3) Here is my family at my daughter's wedding. I have two sons as well as my daughter.

(Hintz 4 and 5) I teach Astronomy classes in our planetarium. Our planetarium seats 45 people and I teach 4-6 classes per year. Our planetarium uses a digital projection system. It has been so nice to have the new system for my classes.

(Hintz6) The pioneers settled in Utah in 1847. Before then, Utah was home to five Indigenous tribes, and before them, others. Utah is known for its mountains, snow, National Parks of natural Arches, hodoos, and the Great Salt Lake.

I am happy to join you today and share with you some interesting archeoastronomy from the four corners area of the USA. My presentation today discusses one of the most unique sites in the United States – Chaco Canyon.

Interview question n.2

(Hintz7) I was first introduced to the Chaco Culture Historical National Park during the summer of 2023. I was attending the American Astronomical Society Meeting in Albuquerque, New Mexico. A great deal of the meeting was devoted to preparation for the two solar eclipses happening in 2023 and 2024 over the USA. As part of that meeting, I attended a workshop by the PUNCH

solar mission where I was introduced to Chaco Canyon and how the residents of that area recorded their understanding of the patterns of the sun and the moon. We are indebted to Anna Sofaer and the Solstice Project for our understanding of the Chacoan culture's astronomy and much of my presentation is taken from their work. Chaco Canyon is found in the northwest corner of New Mexico. It is part of the San Juan Basin. It is a high desert.

Interview question n.3

(Hintz8) There is evidence of residence from about 400 BCE to 1300 CE. Chaco Canyon reached its pinnacle of prominence in the era of 900 to 1130 CE. The Hopi and Navajo trace their roots to Chaco Canyon. Chaco Canyon also seems to have been a destination for learning more than habitation

(Hintz9) The Chacoan culture built large, multi-story buildings and an extensive road system that went out far beyond the canyon. The Solstice Project has determined that 12 of the 14 major buildings have walls that align with the locations on the horizon of either the rising sun or moon during the important times. There are also petroglyphs that seem to track the passage of the sun and moon over time.

Interview question n.4

(Hintz 10) Since the Earth's axis of rotation is tilted with respect to its orbit around the sun, the sun will cross the sky over different paths as seen from the same location on the surface of the Earth. The image on the right shows different paths for the sun. The sun will also rise and set at different spots along the horizon during the year. It rises straight east on the days of the equinoxes. It will rise farthest north of east on the horizon on the summer solstice and farthest south of east on the winter solstice. This is for us in the Northern Hemisphere. It follows this pattern over the course of the year and repeats.

(Hintz11) The image shows different paths for the sun. The sun will also rise and set at different spots along the horizon during the year. It rises straight east on the days of the equinoxes. It will rise farthest north of east on the horizon on the summer solstice and farthest south of east on the winter solstice. This is for us in the Northern Hemisphere. It follows this pattern over the course of the year and repeats.

(Hintz12) The openness of Chaco Canyon allows an excellent view of the rising sun on the cliff faces in the horizon. This image shows the location of the sun on the horizon of Chaco Canyon for the four major days of the year as seen from a Kiva or ceremonial circular chamber. If you were a Chacoan and stood at this exact spot, you would see the sun rise at that same location on the horizon for every summer solstice, or this spot for every equinox and this spot for every winter solstice

Interview question n.5

(Hintz 26) My building has a west facing exterior door that connects to a long hallway right by my office. There are a few days during November and January, when the setting sun shines right down our long hallway. We affectionately call them our Stonehenge days.

(Hintz13) Because the Moon orbits the Earth in less than a month, we will see the Moon's rising location on the horizon vary over just the month. This will be even more obvious near the dates of the solstices. If it is the summer solstice the waxing crescent Moon will rise and set north of east, but the full moon, two weeks later, will rise south of east. But there is even more to do with the Moon. We are likely all aware of the Moon's orbit being tilted with respect to the ecliptic by a little more than 5 degrees. We usually discuss this with respect to eclipses and why we don't have eclipses every month.

(Hintz14) But if instead, we just concern ourselves with the Moon's declination (or height above or below the celestial equator), there are some additional terms we need to introduce. If the Moon is at the farthest point away from the

ecliptic , the Moon's declination would be at 28.7 degrees above or below the celestial equator. This is called a Major Lunar Standstill.

As seen from the surface of the Earth, the Moon rises even more north of east or south of east on the horizon than the sun did. If the Moon is the 5 degrees closer to the celestial equator than the sun, at a declination of 18.1 degrees, that is called a minor lunar standstill. It takes 9.3 years for the Moon to transition from a Major to a Minor lunar standstill. As seen by the human eye, it seems to return to the same location on the horizon, for a few months. It requires technology to get the precise value, so the ancients would have dated the time between Major and Minor lunar standstills to be somewhere between 9 and 10 years. Those numbers will be important later. And of course it would be 18.6 years for the full cycle from Major Lunar Standstill to the next Major Lunar Standstill.

Interview question n.6

(Hintz 15) Inside Chaco Canyon is Fajada Butte, an isolated butte that stands 135 meters above the valley floor. The butte is difficult to climb and has no water source. But there is lots of evidence that people were there because of the many examples of Rock Art.

(Hintz 16) Near the top is a narrow ledge where three stone slabs lie in a row in front of the cliff face. They lean slightly off vertical and fan out radially. You can see them in the photo here. The slabs are between 2 -3 meters high (taller than me), 0.7 - 1 m wide and 20 – 50 cm thick. They likely weigh about 2000 kg each. The slabs are about 10 cm apart at their closest, near the cliff face. The slabs are very natural looking and are believed to have come from a single slab that's broken apart. But they do show signs of modification or carving in a few spots. The slabs are firmly in place and partially supported by surrounding stones.

(Hintz17) On the cliff face behind the slabs, two spiral petroglyphs are carved into the rock face. You can only see the spirals from the right side of the stone slabs. One spiral is elliptical in shape with 9 ½ turns and is 34 cm by 41 cm. The smaller spiral is above and to the left. It has 2 ½ turns and has an extended loop

off to the right side. When viewed from the viewing location on the right of the slabs, the Solstice Project says the large spiral looks circular in shape

(Hintz18) The three slabs create two openings and light from the sun (and moon) will shine through the openings and create light patterns on the cliff wall behind the slabs. Most of the year, as expected, there are two light beams that hit the cliff face during the middle of the day with a duration of 3 hours during the winter to under 20 minutes during the summer. But it is on the days of the solstices and equinoxes that really demonstrate the amazing feat of this site.

Interview question n.7

(Hintz19) On the date of the summer solstice the light shining through the left opening is hardly visible at all, only a small dot. It's likely that 1000 years ago, it didn't shine through at all leaving only the projection through the right opening casting light on the rock face. (There may have been some slight natural erosion effects on the slabs that may have shifted them to allow this small amount of light.) Light that shines through the right opening on the summer solstice, starts as a dot at the top edge of the larger spiral, then turns into a thin vertical form that lengthens and descends downward through the middle of the spiral. When it reaches the half-way point in time of being visible, the shaft is centered both vertically and horizontally on the large spiral and then continues to go downward until it disappears near the bottom of the spiral. This only takes about 18 minutes. Both the centering of the light shaft on the large spiral and the lack of light through the left opening would be precise markers of the summer solstice.

Interview question n.8

(Hintz20) Yes, this marks the beginning of summer. On the winter solstice the left shaft begins at the extended loop of the small spiral and then descends

downward. Later the two light shafts frame the outside of the large spiral when both shafts of light hit the outermost grooves.

(Hintz21) On the equinoxes, the left shaft's light bisects the small spiral. The right shaft hits the larger spiral between the fourth and fifth turn of the spiral. You can see all the patterns in this drawing from the Solstice Project. This location seems to be a very definitive solar observatory, and it is given the name "Sun Dagger" because of it. The Full Moon is capable of causing light projections through the slabs as well and when the Moon is found at the same locations as the sun, the same patterns are seen. Every carving of this location seems to have significance like the extra loop of the small spiral and the center and outer edges of the large spiral. But it's even more impressive when we include shadows cast by the right slab when the sun or moon are rising.

(Hintz22) On days when the sun or moon are at a declination of 0 degrees, on the equinox for the sun, the shadow's edge falls along a tangent of the right groove of the large spiral. The shadows cast during the solstices don't seem to mark any special location on the spirals. But they do for the lunar standstills. When the sun was located at the declination for the Minor Lunar Standstill point of 18.4 degrees declination, the shadow bisects the large spiral and the angle of the shadow corresponds to an additional carved groove found in the spiral. Artificial light sources with laser angling were used to simulate Lunar Major Standstill because the sun never gets that far north, and the Moon wasn't going to get there for 5 more years when this was done. The simulated shadow hit the tangent of the left side of the large spiral. The spiral itself may hold more information about the Moon's motion over time. Remember I told you it takes 9.3 years to go from Minor Standstill to Major Standstill. The shadow at the Sun Dagger crosses over 10 grooves from the center to the left side of the spiral. The length of the full cycle, 18.6 years, may be carved out by the count of 19 grooves of the whole spiral. Incidentally this spiral has the largest number of turns than any other spiral in the area. It is considered very unusual because of the large number of turns. I am convinced that the Sun Dagger near the top of Fajada Butte marked the four quarter times of the year of the sun, as well as the two major points of the Moon in its 18.6 year cycle.

Interview question n.9

(Hintz23)

The Solstice Project discovered two other sites on the Fajada Butte that make use of petroglyphs, light and shadows to mark the sun's meridian crossing. Remember the sun's height in the sky changes through the year, so the rocks casting the shadows on the locations vary in bearing and distance from the petroglyphs throughout the year. Regardless the spiral petroglyph on the east gets hit by light and shadow all year within 15 minutes of solar meridian crossing. Somehow the Chacoans found the perfect spot. There may also be distinguishing projections for the solstices and equinoxes. The images taken for these sites are difficult to see so I am not showing them here. You can look up information about them at the Solstice Project Website.

Interview question n.10

Je n'ai pas vu le poignard solaire moi-même. Fajada Butte est fermé depuis 1989.

(Hintz 24) The PUNCH workshop that I attended was all about outreach on the topic of solar eclipses. In Chaco Canyon we were shown a petroglyph that is being interpreted as a record of the July 17, 1097 Total Solar Eclipse that was visible in Chaco Canyon. This hypothesis was first suggested by Dr. Kim Malville in the 1990s. He suggested that this is actually a carving of the sun and the curlicues seen in the petroglyph are from a coronal mass ejection seen in the corona during the eclipse. The sun is believed to have been particularly active during this time, called the Medieval Maximum. The carving to the left above the sun could represent Venus, which would have been to the left, above the sun as seen during the total solar eclipse.

In my simulation using Stellarium, Venus doesn't really look that close.

We know that compared to European countries, the US is very young. But we recognize that the ancestral Puebloans that lived here 1000 years ago created amazing civilizations and were amazing astronomers. As I mentioned, much of our understanding of Chaco Culture related to Astronomy was done by the Solstice Project. Here are three articles I used for this presentation. You can learn more at the Solstice Project, the US National Park Service Website. Sadly the Sun Dagger's fame caused too much foot traffic and the slabs have shifted and no longer correctly time the solstices and equinoxes and the Fajada Butte is closed to visitors.