

Sun, Sand, and Solitude

by Jim Bishop

In the southwest corner of Texas, the Rio Grande River arcs across some three hundred miles of arid desert country from Presidio to Del Rio, separating the US from Mexico. Nestled in the western half of the large S-curve of the river stands Big Bend National Park. The least visited of all our National Parks, it has in some respects the most to offer - especially dark, clear night skies¹ for stargazing. In fact, the park is located in the same general area as McDonald Observatory and is a favorite spot for astronomy enthusiasts. Located in the Chihuahuan desert, park days are warm and sun is abundant, to say the least.

The mission of the Big Bend Natural History Association (BBNHA)² is to provide books and literature, including several astronomy books and software packages, to the visiting public to help in the interpretation of all the park has to offer. Combining the mission of BBNHA with the natural abundance of sun and the area's link to astronomy, what better place for a sundial? After some discussion with Mike Boren (see Figure 1), the Executive Director of the BBNHA, I designed, constructed, and finally installed a polar dial on the 4th of July, 2002.

My criteria for the dial was that it must show standard time, have an unusual or pleasing design, be educational, and withstand the extremes of sun and temperature the park experiences. A polar (Briggs-like) dial seemed to fit the bill for the first three criteria, but how should the dial markings be transferred onto the dial, and what material should be used?

With no specialized CAD software available to me, it



Figure 1

seemed more appropriate to write my own program. Given the equations for declination, EOT, and the x-y coordinates for the layout of a polar dial³, a few evenings of coding resulted in a program⁴ that held in memory a bit map of the desired dial image. A separate program⁵ to generate a BMP file from the dimensions of the bit map and a list of its hex byte values completed the core of the programming tasks. These programs are available in the Digital Compendium. Although the program was not very fast (10 minutes on an 800 MHz system), an accurate bit map was produced, imported into Corel Draw®, and textual labels were added.

Now, how to transfer the computer image onto the dial itself? Fortunately, several local trophy shops had laser engraving devices, and for a very reasonable fee etched a Corel® image directly onto a suitable material. I used a scrap cutout of white counter top laminate. The engraving machine "burned" the image into the plastic and darkened the etched pattern. Filling the etching with a contrasting color (black paint) was not necessary. The results were extremely clean and professional in appearance. Simple conical pins were used for the gnomons. As a guide, the length of the etched line above the word "North" equals the required height of each gnomon.

The polar dial caused quite a stir among the park staff when it was first delivered. Hopefully it will provide the same level of interest and enjoyment to the visitors of Big Bend National Park. Thanks to Mike Boren for his continued support of the project.

Footnotes and References:

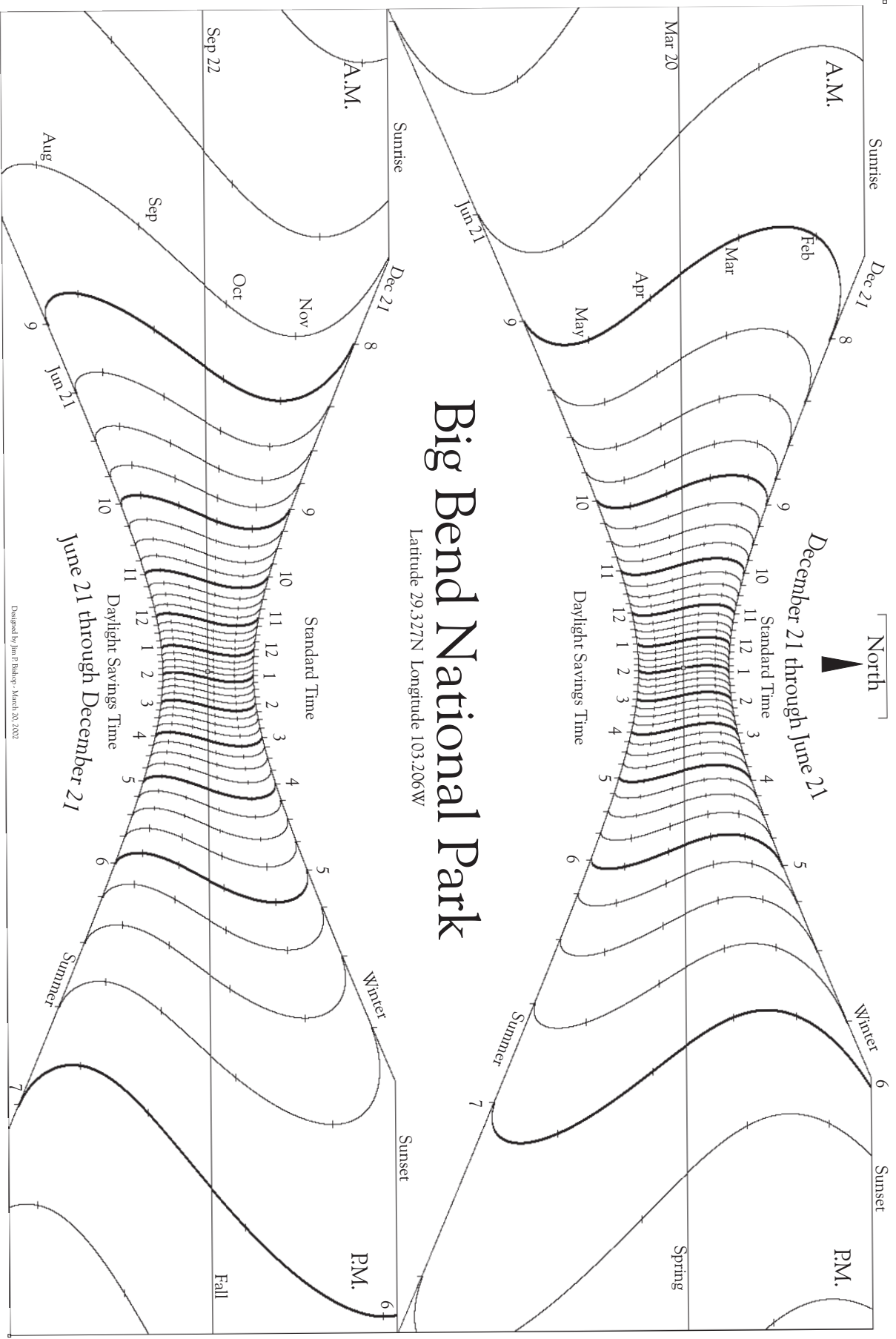
¹ Unfortunately, degrading air quality in Big Bend has become a truly serious problem. See <http://www.nps.gov/bibe/home.htm> for more information.

² The Big Bend Natural History Association may be found online at <http://www.bigbendbookstore.org>

³ Waugh, Albert E., Sundials: Their Theory and Construction, Dover Publications, New York, 1973.

⁴ POLAR2.EXE generates a bitmap for a Briggs-like polar dial given as input the latitude, longitude, and Central Meridian. A raw byte-wise representation of the memory mapped image is dumped to a simple temporary ASCII file (POLAR.DAT), and MAKE-BMP is called to create the actual BMP file.

⁵ MAKE-BMP.EXE generates a black and white BMP file as output (MAKE-BMP.BMP) given an input filename which contains (in ASCII) the x-y dimensions of the bit map followed by hex bytes that represent the individual pels of the bit map image.



The vast, dark night skies of Big Bend immediately attract the interest of astronomers, both amateur and professional. Stars and planets have entertained observers for centuries, but the motion of the Sun has been studied longer than that of any other celestial object.

Prior to the invention of the mechanical clock, the Sun's motion was used to tell time. The sundial was a simple device that used no power, had no moving parts, and could be very accurate. Over the centuries, clever inventors designed dozens of varieties of sundials. The one shown here is classified as a "polar" dial. A line connecting the tips of each gnomon (pin) points to the north celestial pole near the star Polaris, the North Star. As the Sun sweeps across the sky, the shadows of the gnomons move from left to right on the dial face.

But Sun time, called apparent time, is not the same as clock time, called standard time. It takes 53 minutes for the Sun to travel from the Central Time Zone meridian of 90 degrees West to reach Big Bend at

103.2 degrees West. This time difference due to longitudinal displacement must be taken into account and is why the sundial is centered horizontally around 12:53PM instead of 12 noon.

Unfortunately, the Sun's motion in the heavens is not quite uniform, and two additional factors must be considered to correct the difference between Sun time and standard time. First, the Earth's orbit around the Sun is an ellipse, not a circle, and the Earth's orbital speed when nearest the Sun (perihelion) is a bit faster than when farthest from the Sun (aphelion) causing a few minutes deviation from clock time. As the Sun's declination, or angle with the Earth's surface, changes through the cycle of seasons, a second deviation from standard time arises.

The sum of these two effects is known as the "Equation of Time", the correction factor that finally translates Sun time into standard time. It varies from +14.4 to -16.4 minutes over the course of a year. Many globes and atlases represent this solar time variation

as the familiar "figure-eight" known as the analemma, which depicts the Sun's position relative to standard time as its declination cycles throughout the year. The hour lines on this sundial are distorted instead of straight due to this Equation of Time correction factor.

For ease of reading, this polar dial splits the figure-eight Equation of Time factor into two parts of the year. The Winter and Spring months are read on the upper half of the dial while Summer and Fall months are read on the lower half. Daylight Savings Time is marked by the lower hour numbers. Standard Time uses the upper hour numbers.

The sundial serves as a calendar as well. The days of the year are read directly off the dial as the Sun's declination changes from low in the southern sky in the Winter to more directly overhead during the Summer months. Enjoy the simplicity of this ancient device as you contemplate the precision of the Earth gliding silently around the Sun.

Designed by Jim P. Fishap - March 20, 2002