

THE American Surveyor

A FOOT IN THE PAST... AN EYE TO THE FUTURE

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Building a Sundial

Applying astronomy skills

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“WIENHENGE”

The Weeks Field Sundial Project

How do you make a clock that has a four-foot dial, a seven-foot hour hand, no moving parts and is solar powered? Make it a heliochronometer and it'll tell time all year long except on cloudy days and at night. But will a sundial work near the Arctic Circle in the winter? That was my project goal in 1992, but it took me until winter solstice 2010 to actually call it finished. Why so long? From inception to the moment when 300 pounds of steel, aluminum and bronze finally synchronized to tell the time of day in Fairbanks, Alaska, here is the story.

I work at the Fairbanks North Star Borough as the senior platting officer reviewing subdivision applications for land development in a municipal area of 7,361 square miles (19,065 square kilome-

ters). It has a population just under 100,000 with the majority clustered within a 25-mile radius of the town center. Two small cities lie within the borough: Fairbanks proper at 32,500 and North Pole (where it's Christmas all year long) at 2,200. The borough was formed in 1964 after the City of Fairbanks was chartered in 1904, and North Pole in 1953.

I got the idea to construct a sundial in town when a survey of the local library came in for review. The borough owns the Noel Wien Library located on 17 acres of land called Weeks Field Park adjacent to several schools. The Weeks Field Garden Club is a nonprofit organization formed to spruce up the grounds with flowers, shrubs, birch and even a few spruce trees to give color along the paved pathways between the schools and library. I contacted the club to ask if they had any statues or garden plots planned

>> By Martin Gutoski, LS



Martin Gutoski winds up the clock at the winter solstice to verify the final check on the alignment of the propeller.



Martin points out the dim sun shadow illuminating the winter solstice at high noon on December 21st in Fairbanks, Alaska.

around the boundary so I could determine if any survey corners were in jeopardy.

A new parking area had been designated for the proposed library expansion for which the borough commissioned a survey for the control points in the construction. Seeing the garden club plan confirmed there were some potential close encounters of the survey kind with these monuments. Advising the club of some caution areas near the parking lot they should avoid, I casually remarked about a planned statue for pioneer aviators. It had been the dream of a similar nonprofit that ran the Pioneer Aviator Museum at another borough park to commemorate the early aviation history of Fairbanks by commissioning a bronze statue near the library, featuring figures dressed in WW II military flight suits for Russian and American pilots involved in the Lend-Lease program.

Weeks Field was the original airfield in Fairbanks that began with the first

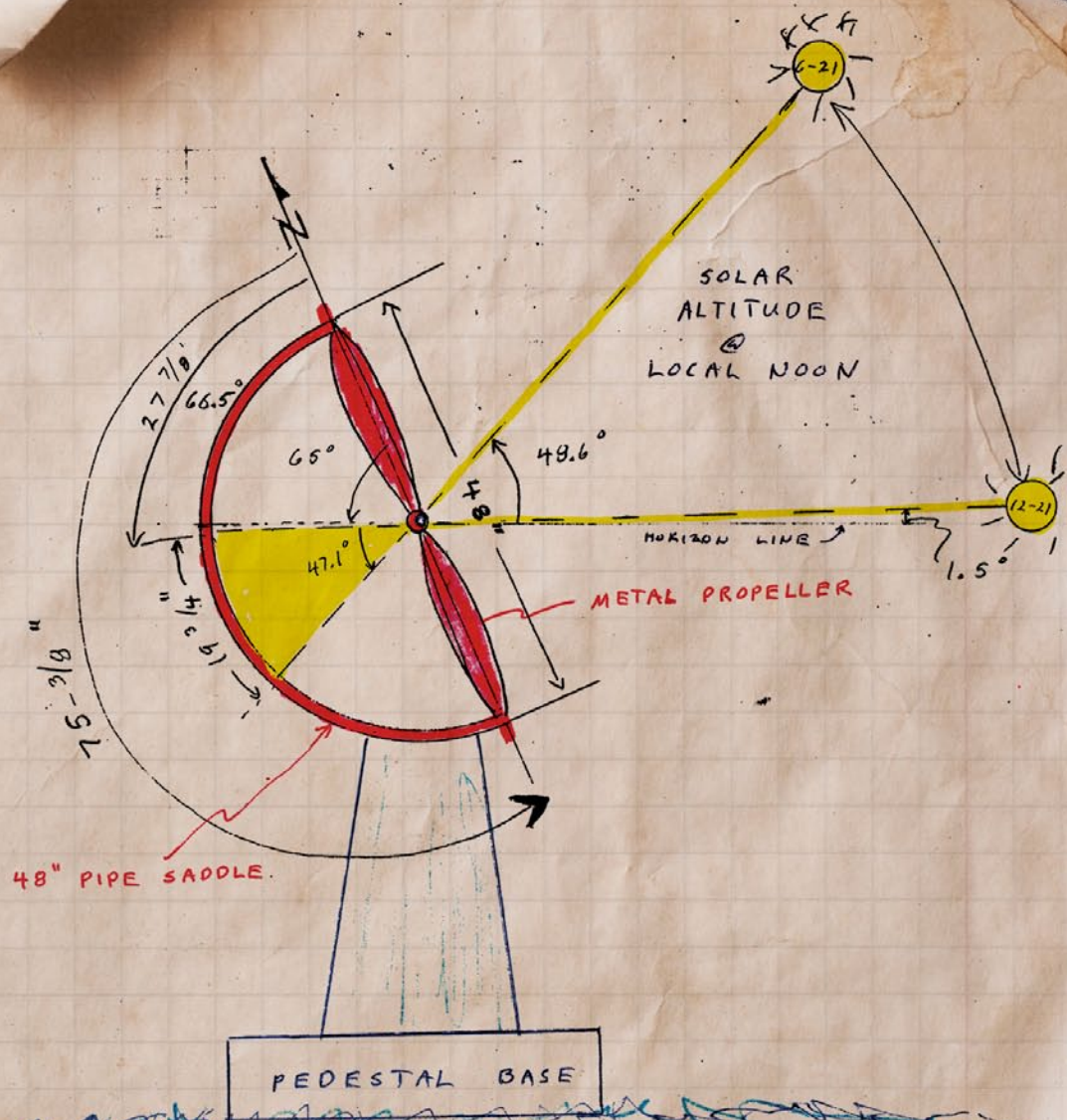
commercial flight by Noel Wien in 1924 flying airmail and supplies north in a surplus WW I biplane. Over the next quarter century Weeks Field was central to aviation development arising from Fairbanks that served the north until the airfield was decommissioned in June 1951 with the completion of the new Fairbanks International Airport a few miles farther from the expanding town. The city subdivided the western part of the airfield into residential and commercial lots, and made the north-central portion into a park with the eastern and southern parcels retained to build three schools.

When the borough was formed in 1964, it eventually took over schools and parks from the city. Weeks Field was the new location of the Noel Wien Memorial Library built with post-pipeline money in 1977. The completion of the Trans-Alaska Pipeline in 1976 and steady gush of oil revenue to the state



A 1/4" scale model was built from plastic sewer pipe and a model airplane propeller to test the sundial design at winter solstice.

The original design sketch for the sundial concept presented to the Weeks Field Garden Club.



FAIRBANKS ASTRONOMICAL UNITS

WIEN PARK SUNDIAL

SUN SHINES THROUGH PROPELLER HOLE ONTO PIPE SADDLE
ONLY AT HIGH NOON EACH DAY - DATES ARE STAMPED
ONTO SADDLE TO INDICATE LOCAL SOLAR NOON TIME



The full scale wooden mockup in summer installed at Weeks Field. The rust colored lines indicate the arc of the maximum and minimum sun angles between solstices, which is a little over a 47 degrees span at Fairbanks latitude of nearly 65 degrees north.



The full scale wooden mockup in winter installed at Weeks Field. The bottom of the painted red arc at the top face of the dial is where the sun's shadow should fall on winter solstice around December 21st when the sun reaches a maximum altitude of barely 1.5 degrees above the horizon.

translated into geysers of money flowing into municipal coffers from the royalties. Fairbanks experienced unprecedented growth for the next decade which resulted in many new public facilities like the library, schools and parks to meet the needs of a boom population.

I asked the garden club what they had planned in place of the statue. They replied that they were still looking for something, but no one had come forward with a plan. Having used Noel Wien library for public events in a parallel universe as an amateur astronomer outside my borough employment as a surveyor, I proposed that maybe the garden needed a sundial. In 1987 I had formed a group called the Fairbanks Astronomical Unit (an astronomical unit is the average distance between the sun and earth, roughly 93 million miles) to provide public outreach for the viewing of Halley's

Comet. Noel Wien Library and several of the nearby schools had been a venue for these "star parties" using telescopes to show people the comet. After that we continued providing celestial events featuring the sun's shadow at the solstices and equinox. I suggested a sundial would be a great centerpiece for those topics.

So in 1992 we began to plan for the sundial at "Wienhenge." We submitted a hand drafted concept drawing to present to the garden club board for consideration. What I envisioned was an aviation theme tied to the Trans Alaska Pipeline, both monumental episodes in Fairbanks history. I worked on the pipeline from Prudhoe Bay to Valdez in the construction boom from 1974 to 1984. Nothing was more instrumental in the pipeline construction than the miles of supports that kept the warm pipe above ground that passed over the permafrost which

would have melted if it was buried the entire length. I laid out hundreds of them mile after mile along portions of the 800 miles that ran from Prudhoe Bay to Valdez. Nothing evidenced the travails of aviation in Alaska more than a bent prop, and I knew a few pilots who screwed theirs into the ground on the gravel strips that blanket the valley. The ladies of the club thought every garden should have a sundial around which they would plant sunflowers.

Making the Model

I started with a quarter-inch scale plastic model made of a piece of four inch ABS sewer pipe cut in half lengthwise for the arms and a six-inch propeller from a flying model airplane. The prop would be the gnomon which cast the shadow across the dial. The angle of the prop in the arms would have to be set at our



Martin points out the sun shining through the propeller hole at the autumnal equinox. The bronze hour marks are set for the Alaska Standard Time (AST) or Alaska Daylight Time (ADT) difference when it changes. Alaska is on one time zone which makes apparent solar time vary by up to two hours from civil time at the Fairbanks Meridian.

latitude and mounted facing south to catch the right sun angle. Basically the prop's long axis is aligned with Polaris like an equatorial mount on a telescope, and the dial face points due south to catch the sun's shadow to mark time.

Especially iffy was the winter solstice sun which doesn't get above two degrees altitude during the less than four-hour period it skirts the horizon in Fairbanks on the shortest day. I computed the altitude of the sun at high noon so that the center hole of the prop would cast a sunlit circle onto the arms of the dial to mark not only the hours, but the maximum and minimum altitude that marked the summer and winter solstice. The midpoint to which the sun returned at the two equinoxes would be dead center on the hour arm.

The plastic model was mounted on my deck at home to go through a full year cycle for a long proof of concept phase. Satisfied that it would work, I then needed to choose a location at Weeks Field that would have an unobstructed southern horizon.

The park is skirted by large spruce and birch trees that have grown up in the 50 years since being planted along the perimeter road that became Airport Way. Added to the clutter in the south are two schools, one with a tall theater loft and

the other an indoor swimming pool roof. There was a short gap between the two that also had a break in the trees for a sidewalk. With compass and camera in hand, I crabbed back and forth laterally to find the sweet spot that would allow the sun to pass through at the winter solstice.

As any surveyor would do, I set a spike with orange flagging into the frozen ground on December 21st to come back in the summer to lay out the base. Returning on the vernal equinox and summer solstice with an accurate watch to mark the meridian crossing of the sun verified the location. I built a full-scale wooden mockup with a six-foot long 2"x6" board with a 1½-inch hole drilled in the middle to stand in for the prop. This annual cycle of timing and photography went on for a few more years because cloudy days on the winter or summer solstice bumped the schedule back.

In the meantime I rustled up the materials needed for the full metal version. A six-foot bent prop was donated by an aviation repair shop in town that had plenty of boinked blades which couldn't be re-trued in their machine shop. Alyeska Pipeline Service Company, the maintenance operator for the pipeline, donated one of the four-foot diameter galvanized three quarter-inch thick steel saddles used to support the pipe.

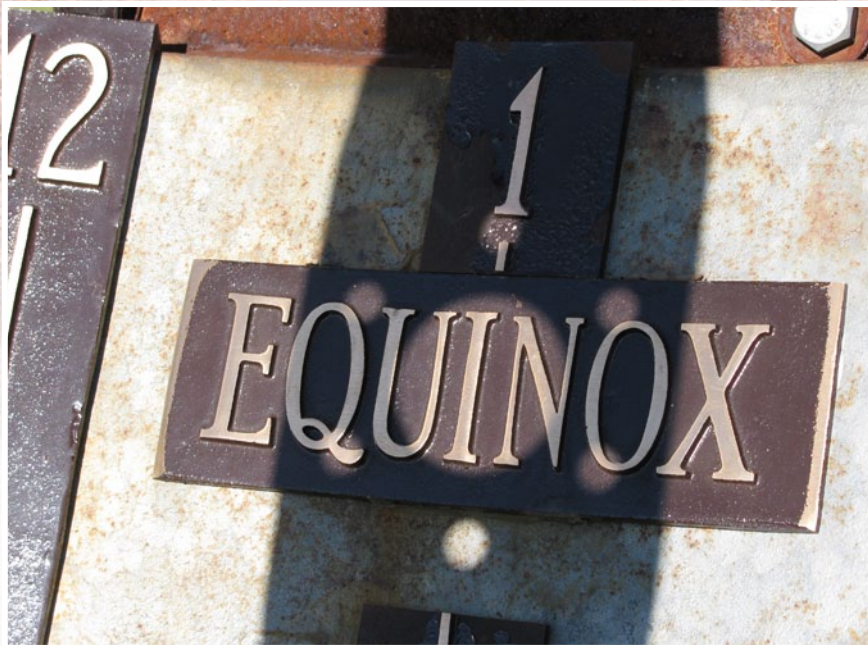


The test of the survey computations using the stand-in propeller from the wooden mockup and the first half of the pipeline saddle to verify the alignment at summer solstice. The small oval spot of light on the lower part of the saddle is cast when the sun is at nearly 49 degrees maximum altitude.

Vandals and Patience

After my doing the sun dance for several years, the wooden mockup was destroyed by vandals, so I figured it was time to do the real thing. I jogged the final location a foot farther west to avoid a chimney on one of the schools, and ran a traverse from two of the survey corners that were set on the east boundary of the library parking lot to determine a due south line. To complete my survey verification, I ran a sun shot with an old Sokkia theodolite to get a true meridian.

Finally the pier went in the ground and was allowed to settle for another year before I mounted the prop. It took several more annual cycles with the arms and prop temporarily bolted in to follow the sun's shadow across the back of the dial. Many Magic Marker tick marks were placed where the sun circle



The spring equinox test of the final sundial alignment after a decade of fine tuning showing the sun shadow through the holes in the propeller at high noon.

passed over the arms to determine the final adjustments in azimuth and altitude angle before they were welded at the proper angle to match the 64° 51' North latitude location.

Just after the final mark was made, vandals struck again and broke the propeller off its bolts. I soon found another bigger but less bent prop from a pioneer aviator's family to replace it. This one was sexier because it was not painted black but was longer (seven feet), made of burnished aluminum with a bigger hole and six smaller bolt holes in the center. The sun shines through the circular array like it has six planets orbiting around it to imply the Copernican heliocentric system of the naked eye solar system.

Yielding the arms of the dial to the welder's torch and welding the bronze hour marks along with the solstice/ equinox plates still allowed me to tweak the propeller. I was able to slide the prop up and down a few inches with steel straps bolted through the holes in the saddle which were manufactured originally to clamp the pipeline onto the above ground supports. After five years of annually tweaking the propeller to make the solstice marks match the equinox when the sun casts a two-inch circle across the bronze markers equally, the Dec 21st winter solstice looked right on the mark from the last equinox adjustment I gave it in the fall of 2010.


This sundial was constructed by Martin Gutoski of the Fairbanks Astronomical Unit. The bent propeller was donated by the owner of a small aircraft that crashed on takeoff. The arms of the sundial are cut from pieces of the Trans-Alaska oil pipeline.

The dial is oriented to the south so that the shadow of the propeller centers over the hour of the day for either Alaska Standard or Alaska Daylight Time as shown on the horizontal arm. The small chart on the left side is for adding or subtracting the minutes of time to adjust for the seasonal difference between apparent sun time and local civil time.

Sun shining through the center hole of the propeller will cast an outline across the bronze plate marking the two Equinoxes when they occur in September and March. At the time of the Winter and Summer Solstices, the sun circle will cross the bronze plates attached to the vertical arm above and below the horizontal arm respectively.

The wording on the bronze plaque installed near the front of the dial to explain the design and use of the sundial to mark 12 hours of time based on the sun's annual passage in the southern sky.

The fusion of the historical airfield from which Fairbanks grew outside its boundaries and pipeline boom which resulted from that long reach out to Prudhoe Bay oilfields that refueled Fairbanks economy is embodied with the melding of a bent propeller supported in the arms of a pipe saddle to tell time. Surveyors had a significant part in both pioneering phases of expanding the reach of Fairbanks, line by line, until it reached Prudhoe Bay by first airfield hopping and then running a highway north to the Arctic Ocean. Surveyors

then brought an 800-mile long kinky line four feet wide from Prudhoe Bay to Valdez Sound to siphon the wealth through Fairbanks at the midpoint where I placed a four-foot aluminum capped pipe monument with bronze ticks to mark the time. 

Martin Gutoski is a senior platting officer for the Fairbanks North Star Borough, and holds a master's degree in anthropology. He has been surveying since 1966, and professionally since 1988.