Super Accurate Heliochronometer Sundial (2025 Edition)

Submission for the British Sundial Society Design Awards (2021–2025)

Designer / Maker: Marc-André Nadeau
Location: Private site in Vernon, British Columbia, Canada
Submission Category: Sundial Design Innovation

Overview

This sundial represents a precision-engineered heliochronometer developed to achieve minute-level accuracy through geometric & mechanical adaptation of the Equation of Time. The design integrates adjustable latitude & declination dials, meridian offset and a geared spherical Analemma plate which provides exceptionally precise readings throughout the entire solar year. The model is both functional and educational, offering an engaging demonstration of astronomical timekeeping using accessible 3D printing methods. Its design simplifies traditional heliochronometer principles into a compact, printable format accessible to modern makers.

Technical Features

- Supports both Northern and Southern Hemispheres;
- Constructed from 3D printed components, requiring no specialized machining or tooling;
- Suitable for both educational and precision timekeeping applications;
- Time readings are accurate to < 1 minute throughout the entire solar year from any location. In practical terms, however, the accuracy will always be determined by the quality of its construction, assembly and precision of its final alignment;
- The time reading is "*tuned-in*" by turning a knob located under the main hour dial. Rotating the knob moves the entire Alidade, Nodus & Analemma assembly via a series of gears which enables the precise positioning of the sun's shadow against the Analemma vertical plate. The time is then read from the main hour & minute dials;
- The main dial crescent has a coarse time reading resolution of 5 minutes;
- The Alidade is coupled to a 0 to 60 secondary minute dial with a finer 1-minute reading resolution;
- Adjustable Latitude Scale Dial with 1 degree reading resolution;
- The Alidade consists of circular Vernier, consisting of a sun gear & a planetary gear traveling around an outer ring gear on the main dial plate;
- The main dial crescent, along with the secondary minute dial, displays Local Mean solar time directly by computing corrections to the true, or apparent solar time. It achieves this by utilizing a visual mechanical computer; i.e. Analemma curve;

- It converts Local Mean Time to Standard Local Time directly via meridian offset dial adjustments with 5-minute resolution;
- There is a time compensation feature to the main dial to adjust for Daylight Savings Times;
- A large Analemma plot is provided on a curved (spherical surface) vertical arm for improved reading resolution & accuracy;
- A Tilt Adjustable Nodus hole on curved vertical arm for Sun Elevation Compensation throughout the year. This feature enables a sharper shadow to be cast against the Analemma plate, especially at the elevation extremes;
- The sundial reads time between 5:30AM & 6:30PM. This is due to the design of the crescent main dial which limits the full rotation of the alidade & gear mechanism. If you are looking for an unrestricted time reading outside of this time range, then please refer to my design remix available here: https://www.printables.com/model/1344217-full-main-dial-for-2025-heliochronometer-sundial
- Easy to read & improved resolution for easy print on all dials;
- 4 base options are available; 3 with integrated magnetic compass and levels, and 1 without. For compass/level options, refer to these printable links:
    - **Tri-leg:** https://www.printables.com/model/1012539-improved-heliochronometer-sundial-base-design-with
    - **Leveling base & tripod head:** https://www.printables.com/model/1012575-heliochronometer-sundial-mount-for-head-leveling-b
- Assembly measures 180x200x200mm (W x L x H).

The heliochronometer prototype was constructed out of ABS, but recommend using PETG or ASA for permanent outdoor installations. Use the included 3mf files to simplify the construction process or to make any print adjustments.

How was it Designed

A: Sundial Specifics

For definitions on the various parts that make up a heliochronometer sundial & how they work, see my other Printable at: https://www.printables.com/model/998688-heliochronometer-worlds-most-accurate-sundial

The spherical Analemma plate was calculated & designed using a technique described in one of my other Printables which utilizes several **Python** scripts within **Blender**. Check out ***How a Curved Analemma Plate was Designed into this Heliochronometer*** from: https://www.printables.com/model/1036568-curved-analemma-plate-for-a-heliochronometer-sundi

The Nodus has a tilt feature on a curved vertical arm. Therefore, the Nodus elevation can be adjusted to match the sun's height above the horizon during the course of the year. This results in a sharper sun spot casted against the Analemma plate which also helps with reading resolution.

Both hour & minute dials were generated using an online template design tool; i.e. https://www.blocklayer.com/clock-face The SVG drawing was then imported into **Inkscape** & then modified/enhanced for **Blender**. Once imported into **Blender**, a thickness was assigned to each dial & then saved as an **STL**.

B: Planetary Gear Design Specifications

- **Common to all Gears:**
  - Pressure Angle: 20 degrees;
  - Module: 1;
  - Backlash: 0mm;
  - Root Filet Radius: 0.5mm.
- **1 Planet Gear with Carrier:**
  - 69 teeth;
  - 69mm Pitch Dia.
- **Sun Gear:**
  - 6 teeth;
  - 6mm Pitch Dia.
- **Outer Crescent Gear:**
  - 94 inner teeth;
  - 144mm Pitch Dia.

How was it Assembled

The construction of this sundial is relatively simple, making use of M2, M3 & M4 *Stainless Steel Button or Cap Head Screws and Nuts.* A list of assembly material is provided along with where it's used. All parts can be easily disassembled and reassembled to facilitate transportation. Refer to: ***Gard_Clock_Hybrid_Assembly_Instructions_v1.1.pdf***

How was it Aligned

The following tools are required:

1. Magnetic Compass;
2. Circular Bubble Level;
3. *Alternatives:* Smart phone with: 1) Compass or GPS app, 2) level app.

For alignment procedures, adjustments for time zone meridian offsets, daylight savings time, etc. refer to: ***How_to_Setup_your_Gard_Clock_Hybrid_Sundial-Detailed-Instructions v1.1.pdf***

How to Use

Before using, make sure that:

1. your sundial is perfectly level;
2. your latitude is set on the latitude scale;
3. your sundial is pointing to true north;
4. meridian offset is dialed in, including any daylight savings time.

How to Read the Time: Simply turn the dial knob located at the bottom of the main sundial plate to rotate the Alidade until the light through the Nodus hole is aligned onto the dark curve portion on the vertical Analemma plate. Make sure that you are on the correct left or right portion of the Analemma curve corresponding to the current month of the year. Do not try to move the Alidade from the Nodus, or from the Analemma vertical arms or you will end up damaging the gear system. Only use the knob to rotate the alidade/nodus/analemma assembly. The hour will be displayed on the main hour dial & the minutes on the secondary minute dial. The Alidade pointer will indicate the time to within 5 minutes & the secondary minute dial to less than 1 minute.

Additional Information

Full design details, 3D model files, and photographic documentation are available online:
https://www.printables.com/model/1253811-super-accurate-heliochronometer-sundial-2025

Submitted by: Marc Nadeau — Vernon, British Columbia, Canada
Contact: marc.aka@shaw.ca
Date: October 2025