*Technology, 14(3),83-86, (2011)*

**TECHNOLOGY**

# SAFFRON SUNDIAL MAKING PROJECT

**[*]İlhan CEYLAN**
Karabuk University Technical Education Faculty Mechanical Education Department

**Abstract**

Using the concept of time began with sundials in the world. These clocks measure time with such an important mission in history now has lost its importance with the spread of mechanical and digital clocks. Mobile phone to a computer screen a lot easier now the time to read. This is why until today to reach the date on which the period is used as an indicator of a sundial, and has historical value. Today in history made a sundial made of the need to evaluate the different ways a counterpart. Today's been a feeling that contain symbolic for a sundial, to be compatible with its surroundings, be original and interesting concepts, such as more important than that. In this study, the equatorial sundial made of Karachi University's campus, has been designing and manufacturing analysis. Equatorial sundial is in the form of a symbolic flower of saffron, during the reading of any arithmetic processing is not required, the standard time to show the relief, and copper were conducted, this time the original is interesting and at the same time.

## 1. Introduction

Construction and reading of hours of sunshine today, very little is known about the group the following hours of sun, but can be used at the time.

Table 1. Classification of Sundials [1].

| Equatorial Sundials | Horizontal Sundials | Vertical Sundials |
|---|---|---|
| 1. Classic Equatorial Sundial | 1. Classic Equatorial Sundials | 1. Direct South Way Sundials |
| 2. Armillary Equatorial Sundial | 2. Horizontal Analemmatic Sundials | 2. Direct North Way Sundials |

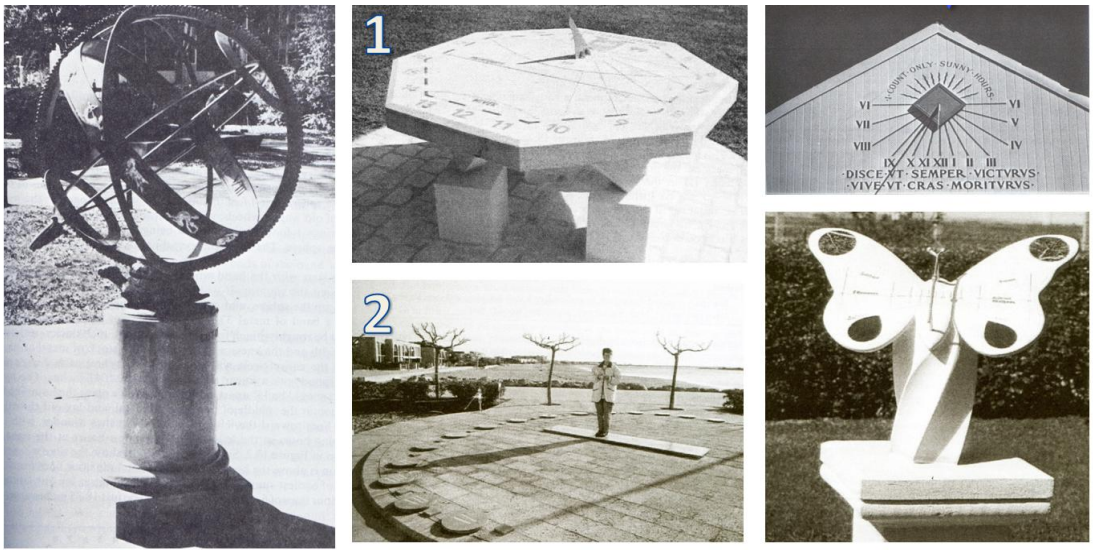


Figure 1. Sundials

*Corresponded Author;ilhancey@gmail.com*

Grouped in Table 1 can be made sundials fixed to a specific place can be as portable as the smaller sizes. As the basis of a sundial, a shadow bar, the floor is composed of figures and numbers are written on. Each sundial is a kind of construction requires no knowledge of solar astronomy and the construction of each is different from the others. Sundial shadow bar, figures and numbers on the floor where the sign of the sundial. Some things to consider when sundial indicator are as follows.

- created a way to correct
- placed in a proper way
- An easy way to be read
- Around compliant
- The indicator is compatible with other materials around
- Interesting
- Original
- Standard time to say
- A feeling of symbolic implications

All times are grouped in Table 1 in the above items desired, sought-after features. You should not need a sundial made of good mental arithmetic, and all corrections should be made mechanically [1]. A country's standard time used by the local or there are some differences between the sundial. These differences are reflected in the time of the sun in the form of correction factors. Correction factors are used to irregularities in the Earth's orbit.

**2. Equatorial Sundial**

Parallel to the equator, the equatorial sun hours of instrument panel. This should be the degree of latitude to the place where the shadow bar clock. In this way, a full-time in the northern direction towards the center of the Earth's shadow is the shadow bar on the display panel. In the summer sun on the equator in the winter because it is under the equator, the northern-way full-time available during the summer. A full south-way shall be required for use in the winter time. All of the points on a meridian is the same as the local time, lunch time in the can at the same time. But the hours of sunrise and sunset would not be at the same time, it is because of where axis. The upright position at 12 noon sun and shade the shorter . The shadow of a stick planted in the ground at 12 o'clock the sun full in the south because the north and the highest position. Monitored to determine the direction of the clock 12 o'clock in the shadow of the rod. To do this, because the magnetic compass is not used and there are significant differences between the polar directions.

Standard time zone meridian time is not done, with the standard time zone meridian east or west of the difference between a 4 and multiplying the added or subtracted depending on the time of the sun. Rotates from west to east as the eastern regions of the world is always ahead of time. For example, the standard time in summer is 45 $^{o}$ east longitude meridian 30 ° east meridian east than 4 times the difference is so minute, so 1 hour is added to the time of the sun.

For example, application of 32 $^{o}$ to 45 $^{o}$ east longitude meridian, east meridian Ankara, the difference between the summer to 13 degrees. 13 degrees, 52 minutes corresponds. According to meridian 45 degrees east to the west where the sun 52 minutes added time. The sun will be back in May, from Table 2, the average time of 3 minutes plus 49 minutes shall be made as a summer setting. Declination is the angle plus the value of the full north-equatorial clock will be available approximately 7 months. Declination angle perpendicular to the sun's rays at noon was taken as the difference in the degree of latitude between the equator with a zone. So, with Declination angle is inversely proportional to length of the shadow. Declination angle is larger than the smallest length of the shadow, shadow long (figure 2) Declination angle is smaller than the greater. Declination angle is the largest value; 23.5. Tangent of this value allows us to find a shadow the length of bar.

Correction factors are used to irregularities in the Earth's orbit . Meridian where the time is done for the country, used to be the same if the reference Meridian used the following equation.

$$S\tan dard\ \ time = Solar\ time \pm correction\ \ factor \quad (1)$$

Table. 2 The correction Factor According to Mounts [2].

| GÜN | OCAK | ŞUBAT | MART | NİSAN | MAYIS | HAZİRAN | TEMMUZ | AĞUST. | EYLÜL | EKİM | KASIM | ARALIK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DAKİKA | DAKİKA | DAKİKA | DAKİKA | DAKİKA | DAKİKA | DAKİKA | DAKİKA | DAKİKA | DAKİKA | DAKİKA | DAKİKA |
| 1 | + 3.6 | +13.7 | +12.5 | + 4.0 | − 2.9 | − 2.4 | + 3.6 | + 6.2 | + 0.0 | −10.2 | −16.3 | − 11.0 |
| 2 | 4.0 | 13.8 | 12.3 | 3.7 | 3.1 | 2.3 | 3.8 | 6.1 | − 0.3 | 10.5 | 16.4 | 10.6 |
| 3 | 4.5 | 13.9 | 12.1 | 3.4 | 3.2 | 2.1 | 4.0 | 6.1 | 0.6 | 10.9 | 16.4 | 10.2 |
| 4 | 5.0 | 14.0 | 11.9 | 3.1 | 3.3 | 1.9 | 4.1 | 6.0 | 0.9 | 11.2 | 16.4 | 9.8 |
| 5 | 5.4 | 14.1 | 11.7 | 2.8 | 3.4 | 1.8 | 4.3 | 5.9 | 1.2 | 11.5 | 16.3 | 9.4 |
| 6 | + 5.9 | +14.2 | +11.4 | + 2.5 | − 3.5 | − 1.6 | + 4.5 | + 5.8 | − 1.6 | −11.8 | −16.3 | − 9.0 |
| 7 | 6.3 | 14.3 | 11.2 | 2.2 | 3.5 | 1.4 | 4.7 | 5.7 | 1.9 | 12.0 | 16.3 | 8.6 |
| 8 | 6.7 | 14.3 | 11.0 | 2.0 | 3.6 | 1.2 | 4.8 | 5.6 | 2.2 | 12.3 | 16.2 | 8.1 |
| 9 | 7.1 | 14.3 | 10.7 | 1.7 | 3.7 | 1.0 | 5.0 | 5.4 | 2.6 | 12.6 | 16.1 | 7.7 |
| 10 | 7.6 | 14.4 | 10.5 | 1.4 | 3.7 | 0.8 | 5.1 | 5.3 | 2.9 | 12.9 | 16.0 | 7.2 |
| 11 | + 8.0 | +14.4 | +10.2 | + 1.1 | − 3.7 | − 0.6 | + 5.3 | + 5.1 | − 3.3 | −13.1 | −15 9 | − 6.8 |
| 12 | 8.4 | 14.4 | 9.9 | 0.9 | 3.8 | 0.4 | 5.4 | 5.0 | 3.6 | 13.4 | 15.8 | 6.3 |
| 13 | 8.7 | 14.4 | 9.7 | 0.6 | 3.8 | 0.2 | 5.5 | 4.8 | 4.0 | 13.6 | 15.7 | 5.9 |
| 14 | 9.1 | 14.3 | 9.4 | 0.4 | 3.8 | − 0.0 | 5.6 | 4.6 | 4 3 | 13.9 | 15.5 | 5.4 |
| 15 | 9.5 | 14.3 | 9.1 | + 0.1 | 3.8 | + 0.2 | 5.8 | 4.4 | 4.7 | 14.1 | 15.4 | 4.9 |
| 16 | + 9.8 | +14.2 | + 8.8 | − 0.1 | − 3.8 | + 0.4 | + 5.9 | + 4.3 | − 5.0 | −14.3 | −15.2 | − 4.4 |
| 17 | 10.2 | 14.2 | 8.5 | 0.4 | 3.7 | 0.6 | 6.0 | 4.0 | 5.4 | 14.5 | 15.0 | 3.9 |
| 18 | 10.5 | 14.1 | 8.3 | 0.6 | 3.7 | 0.9 | 6.0 | 3.8 | 5.7 | 14.7 | 14.8 | 3.4 |
| 19 | 10.8 | 14.0 | 8.0 | 0.8 | 3.7 | 1.1 | 6.1 | 3.6 | 6.1 | 14.9 | 14.6 | 3.0 |
| 20 | 11.1 | 13.9 | 7.7 | 1.0 | 3.6 | 1.3 | 6.2 | 3.4 | 6.5 | 15.1 | 14.4 | 2.5 |
| 21 | +11.4 | +13.8 | + 7.4 | − 1.2 | − 3.6 | + 1.5 | + 6.2 | + 3.1 | − 6.8 | −15.3 | −14.1 | − 2.0 |
| 22 | 11.7 | 13.7 | 7.1 | 1.4 | 3.5 | 1.7 | 6.3 | 2.9 | 7.2 | 15.4 | 13.9 | 1.5 |
| 23 | 11.9 | 13.5 | 6.8 | 1.6 | 3.4 | 1.9 | 6.3 | 2.6 | 7.5 | 15.6 | 13.6 | 1.0 |
| 24 | 12.2 | 13.4 | 6.5 | 1.8 | 3.4 | 2.2 | 6.3 | 2.4 | 7.9 | 15.7 | 13.3 | − 0.5 |
| 25 | 12.4 | 13.2 | 6.2 | 2.0 | 3.3 | 2.4 | 6.4 | 2.1 | 8.2 | 15.8 | 13.0 | + 0.0 |
| 26 | +12.6 | +13.1 | + 5.8 | − 2.2 | − 3.2 | + 2.6 | + 6.4 | + 1.8 | − 8.6 | −15.9 | −12.7 | + 0.5 |
| 27 | 12.9 | 12.9 | 5.5 | 2.4 | 3.1 | 2.8 | 6.4 | 1.5 | 8.9 | 16.0 | 12.4 | 1.0 |
| 28 | 13.0 | 12.7 | 5.2 | 2.5 | 2.9 | 3.0 | 6.3 | 1.3 | 9.2 | 16.1 | 12.1 | 1.5 |
| 29 | 13.2 | .... | 4.9 | 2.7 | 2.8 | 3.2 | 6.3 | 1.0 | 9.6 | 16.2 | 11.7 | 2.0 |
| 30 | 13.4 | .... | 4.6 | 2.8 | 2.7 | 3.4 | 6.3 | 0.7 | 9.9 | 16.3 | 11.4 | 2.5 |
| 31 | +13.6 | .... | + 4.3 | .... | − 2.6 | .... | + 6.3 | + 0.4 | .... | −16.3 | .... | +3.0 |

E=M−A

Compiled from American Ephemeris

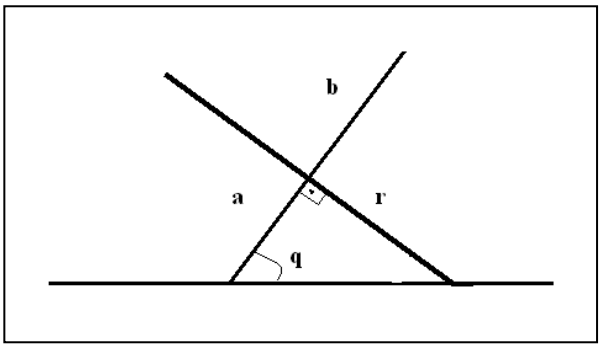


Figure 2. Equatorial sundial shadow bar, and the calculation of the size of the indicator

b: length of the shadow bar
a + b: total length of the shadow bar
r: radius of the instrument panel sundial
q: the time is the area to the degree of latitude

$$a = \frac{r}{\tan q} \tag{2}$$

$$b = r \cdot \tan 23.5 \tag{3}$$

$$a + b = \frac{r}{\tan q} + r \cdot \tan 23.5 + The thickness\ of\ \ dashboard \tag{4}$$

A full north-equatorial sundial in the morning until eight in the evening than four hours at certain times of the year allows us to read. The instrument panel is divided into each 15-degree angles. 1-hour time difference corresponds to the meridian of 15 degrees. Correction factors can be added as time on the graphical or table. Countries do not change this difference is constant for the standard time meridian. Minus meridian towards

the east and west of the meridian and the meridian as a positive right up to the minute difference between 4 and multiplying the added or removed from the time of the sun.

### 3. Saffron Sundial

The first stage focused on the design of saffron equatorial sundial. Design within a few interesting, original, and that the symbolic link with the region where the design was chosen in figure 3. Material to be used to accomplish the second phase focused on the instrument panel is easy to process, and the original reliefs in terms of copper production was started by giving his art and decided to watch. Saffron, nickel plated copper baking sun on the dashboard clock as shown in Figure 3 is produced. After manufacture the instrument panel to place the platform and the direction of the clock have been identified. Hours of material, granite was decided to place the platform. Type the exact direction of north-hour set at 7 months to use. Place in the shadow of a stick stuck in the 12 o'clock and was followed by determining the exact direction of north and south has started the construction of the platform. Figure 3 shows the construction phase. Production of aluminum material in the bottom of the display panel substrate using the degree of latitude was the province of Karabük.. Turkey is used in two different standard time meridian, and to facilitate reading of the clock to turn around on the instrument panel is made of shadow. These factors added to the clock correction is provided by rotating around itself.

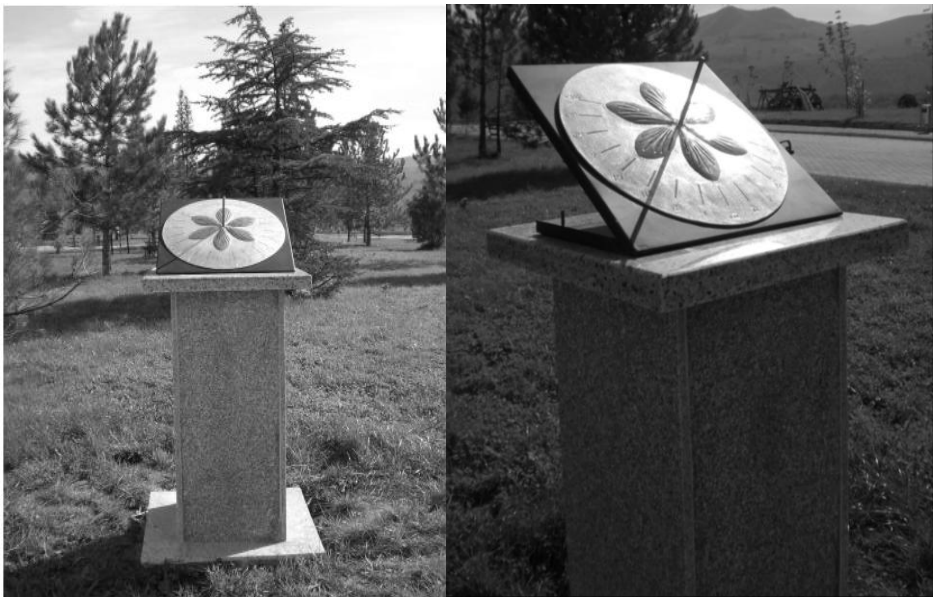

Figure 3. Saffron Sundial

### References

1. Newton R. M, Margaret W. M, Sundials Their Construction and Use, Dover Publications, New York, S, 4 - 102, 1994.
2. Denis S, Sundials Design, Constructions, and Use, Praxis Publishing, UK, S,59- 113, 2009.
3. Waugh, E. A, Sundials, Their Theory and Construction, Dover Publications, New York, S, 32- 94, 1973.