THE CONSTRUCTION OF AN EQUATORIAL SUNDIAL WITH A REFERENCE TO ANAXIMANDER'S SKIATHERON

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Sculpture is interplay of light with shadow. For our perception to 'read' a certain work it needs not only light to see it but also shadow marking parts of it in order to 'describe' it. In the special case of an artistic sundial, the shadow, besides being an element of description of the work itself, yields specific information.

The fascinating *'Anaximander's skiatheron'* served as inspiration for one of the authors, sculptor Andreas Galanakis, to approach the creation of the sundial described here. This *skiatheron* is depicted in a Roman mosaic, now in the Rhineland Museum (Trier, Germany), which shows the philosopher Anaximander holding it, resembles more a butterfly than an instrument.

Diogenes Laertius (B, 1) reports that Anaximander (Fig. 1) was the first to construct a 'gnomon' showing the solstices and the equinoxes and set it in Greece. This happened in Sparta, *circa* 545 BC, i.e. near the date of his death: [1]

> "He also was the first discoverer of the gnomon, and he placed some in Lacedaemon on the sun-dials there, as Phavorinos (FHG iii 581) says in his *Universal History*, and they also showed the solstices and the equinoxes; he also made clocks…"
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> (*The Lives and Opinions of Eminent philosophers*, literal transl. by Charles Duke Yonge, 1853.[1])

The Concept

The shape of the sundial as it is depicted in the Roman mosaic is at the same time graceful and unusual. The passage of the shadow from its plate seems to introduce the viewer into another 'dimension', most unlike the reading of the hands of a simple mechanical clock. It is almost as though it shows another kind of time. A sundial is a point of reference and orientation for a given place, while to some people could even give some motivation for philosophical thinking: metaphorically speaking, the viewer of a sundial is led to the sense that the silently sliding shadow of the gnomon, which every moment separates the surface of the plate into past, present and future, represents the incessant motion of the Universe. The shadow of the light coming directly from a star, our Sun, prompts for a meaning beyond the reading of the hour numbers. Any sundial is a valuable counsellor and also a piece of art that assigns a deeper meaning to our measurable time. Moreover, it requires the place of a work of art, wherever it is set.

The challenge, therefore, for the sculptor/constructor of the sundial was to devise an instrument as an operational work of art. He decided that the sundial should be equatorial; first of all because this form gives more opportunities for development in the surrounding space than horizontal, vertical or polar sundials; in addition, the sculptor wanted this work to connect an obvious reference to the past (Anaximander's *skiatheron*) with a futuristic facet, a reference to the future.

His sundial should resemble more a design or drawing in the three dimensions than a robust monumental sculpture. So the proper selection of its material would be very important to obtain this result. 'Heavy' materials such as marble, cement etc. were excluded under these initial terms. In order to assign this character to the piece of art, the medium

Fig. 1. Anaximander represented with a sundial. Mosaic (3rd century AD) in the Rhineland Museum (Trier, Germany).

Fig. 2. The illuminated hour plate creates a contrast with the un-illuminated body of the sundial.

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Fig. 3. The first version of the hour plate.

Fig. 4. The second version of the hour plate.

Fig. 5. The final form of the hour plate.

should be of small thicknesses and consequently a strong metal. The next thought was to make the plate of bronze; however, this would 'send' the work back into the 'motionlessness' of the past. Bronze resembles gold in colour and metaphorically points to something pompous and heavy.

The selection of stainless steel (inox) gave the flexibility the sculptor was searching for. This metal seems to lose its material essence as light reflects on it. It was not polished, in order to avoid an extraterrestrial appearance and a vivid reflection of the sunlight that would cause problems in the reading of the time. On the contrary, the stainless metal plate was slightly matted; it was subjected to a light sandblasting to make the gnomon shadow more visible and free of blinding reflections of the rest of the surface.

The Hour Lines and Numerals

The geographical latitude and longitude were first determined by GPS at the site of the original presentation and exposition of the sundial; its readings were subsequently checked versus *Google Earth*® software indications, which verified the GPS readings, i.e. latitude 37° 56′ 24.7″ N and longitude 23° 41′ 46.2″ E.

It should be noted here that the site where the sundial is now differs from that initial site by approximately 1 km to the northwest; this difference is negligible for the proper operation of the sundial, although the arc second parts of the above numbers will have changed.

The hour plate was divided into hours with lines every 15 degrees, as any sundial requires. There are also lines for the half-hours, with additional lines carved every 7.5°. Dots (corresponding to small depressions) were used to denote the hours for aesthetic reasons, so that the plate would not have just linear carvings. Small holes were also carved for the quarter-hours around the circumference, so that they form a nice 'necklace' on the sundial's hour plate. Another point to decide was the type of indications of the hour numbers. The sculptor did not want to use the Arabic numerals because they would appear too ordinary, but Roman numerals, would metaphorically point to a 'heavy' and slow pace. On the other hand, the ancient Greek numerals, which are the letters of the Greek alphabet, would restrict our reference only to the ancient Greek past, after the main *skiatheron* concept, thus losing in 'timelessness'. The final idea was for each hour to be identified by just the number of the dots used in the place of hour lines, hinting to the diachronic character and grace of a primal numbering. To this decision contributed another reason: the aesthetic appearance of the work illuminated at night.

The Appearance at Night

Instead of a simple 'blind' carving of the hour plate, the sculptor created, by illuminating it at an oblique angle from below, a contrast between the linear carvings and the holes-dots. Essentially, the illumination is centred on the hour plate, which thus appears as floating in the air, because the supporting structure is un-illuminated.

Fig. 6. The first wooden model.

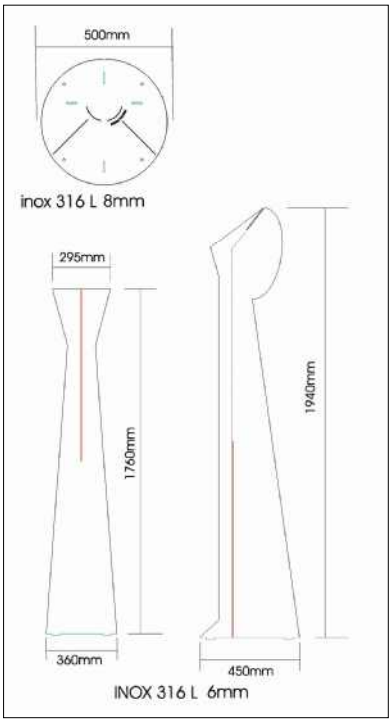

Fig. 7. The construction process.

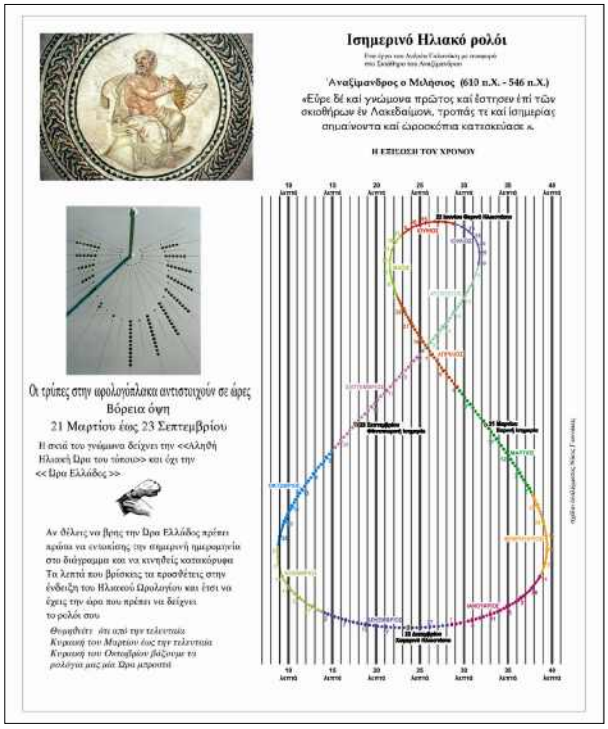

Fig. 8. The 'explanatory' plaque showing Anaximander as depicted in the Roman mosaic, the equation of time with the appropriate explanations, and directions of how to use the sundial, and the reference of Diogenes Laertius to Anaximander (upper right).

The Construction of the Sundial

For the construction of the whole work, the first step was to make some drawings similar to the *skiatheron* held by Anaximander in the Roman mosaic. Next, a small model prototype of the plate in MDF was constructed in order to see the work materialized in space.

The following step was to design the plate in the computer and then 'cut' it in metal to test the material used. After sand-blasting, the first draft was ready. It was also attractive enough for some copies to be given as gifts to friends living around Athens (with a similar latitude, 38° N).

A second version followed. This version was better; however it seemed too 'modern', losing somewhat in diachronic character by taking a rather abrupt and self-conceited jump to the future. Nevertheless, its constructor liked it thus he completed it. This model was on a scale 1:2 with respect to the final size and helped the artist to a better understanding of various details of the construction.

Another hour plate followed, this time a full-scale version. Its thickness was 6 mm. The engravings were seen to be too narrow to show well, having a width of just 0.7 mm, so they were widened to 1.2 mm, which finally proved to be a satisfactory value.

Gradually, the work started to mature as a construction after these tests and the hour plate took its final form, which appears in Figure 5. This had the proper width and length of hour lines, as well as the optimal diameter for the dots-holes.

The corresponding drawings were made with a computer, using the *CorelDRAW 13* software. The guides were glued to wood/MDF and then cut. The wooden model was in full size and was placed in the backyard of the artist's studio. Additional corrections were made upon the final model and then the last drawing took place.

Then the pieces were laser-cut from 6 mm inox, with the relative difficulties imposed by the accuracy of such a construction. The whole work consists of four pieces plus the gnomon. The sculptor thought a lot on the issue of indicating the solstices on the hour plate; he finally decided not to carve them, as they would render the whole plate more complex to read. The gnomon was made relatively large, 23 cm long, for both aesthetic and practical reasons, so that on the occasions when the shadow length is minimum, the shadow would still cover the whole hour plate.

In Fig. 7 the parts indicated in green were attached by TIG welding very carefully, so that the metal would not 'tear'. The red parts were glued with a two-part epoxy. A problem that emerged was the slight bending of the plate under its own weight: it was deflecting downwards by about 1 mm at its highest point. For this reason, a lot of effort was made to pre-tension the plate, so that it would counteract the bending, avoiding inaccuracies at the equinoxes.

The EoT Plaque

The equation of time along with other descriptions – guidelines to the use of the equatorial sundial – were printed and placed under a thick (8 mm) glass glued upon their stainless plaque. This plaque was mounted on a separate base next to the sundial.

The sundial was a donation of the Eugenides Foundation on the occasion of the International Year of Astronomy 2009, while the Borough of Palaio Faliro, south of Athens, hosted it for six months in its seashore park.

Afterwards, at the end of the year, the sculpture-sundial was transported, in early March 2010, to the entrance of the Eugenides Foundation (387 Syngrou Avenue), 1 km from Athens, where there is the modern planetarium with the second largest dome in the world.

Fig. 9. The equatorial sundial in the seashore park of the Palaio Faliro Borough.

Some Technical Comments

Just three months after its placement in the Palaio Faliro seashore park, in December 2009, the side that faced the sea (south-southwest) had already signs of rust. The south-western wind blowing in Faliro since the time of Anaximander comes from Libya (it retains the same name: *livas*) is humid and moreover it carries with it droplets of sea water, the salt of which can deteriorate almost everything. The other (northern) side of the sundial plate was almost intact.

Of course, this was a surface rust, which went away rather easily with a cleaner for stainless materials; however, this incident was a reason for another sand-blasting followed by a conservation spray varnishing with matt varnish for the hour plate only (not the mounting). The gnomon was polished. The final result was very good.

The sundial-sculpture was installed next to the main entrance of the Eugenides Foundation (Syngrou entrance) before March 8, 2010, the date of the inauguration of a new exhibition in the Foundation. Here, at its new site, the sea wind and salt would have a very limited influence.

The technicians of the Eugenides Foundation had already prepared a cement base-pedestal for the sundial. A stainless steel cylinder, 70 cm in both diameter and height, was prepared; a pit 50 cm deep was dug, filled with 10 cm of cement, levelled and on top of this cement base the cylinder was placed. Then the rest of the pit and the interior of the cylinder were filled with cement. On top of the cylinder a horizontal white marble slab was placed and upon this marble the mounting ('trunk') of the sundial was placed and screwed. On March 8, 2010, the evening of the inauguration of the Melina Mercouri Exhibition, the sculpture-equatorial sundial was ready and illuminated.

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Fig. 10: The entrance of the Eugenides Foundation with the illuminated equatorial sundial.

REFERENCE

1. Diogenes Laertius: *The Lives and Opinions of Eminent Philosophers*, transl. by Charles Duke Yong. Ed. H. G. Bohn, London, 1853.

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