Apr 17th, 12:00 PM - 4:00 PM

Ancient Roman Timepieces

Mariah Piippo
University of Northern Iowa

Ancient Roman Timepieces

by
Mariah Piippo

Edited by
Chase DeBont and Michelle Patrilla

For
Ancient Roman Art
Dr. Charles M. Adelman
April 11th, 2019

Romans heavily borrowed and imitated technology from cultures they encountered across the Mediterranean, and Roman sundials and timekeeping was developed from their influences and encounters with these other cultures.[1] Sundials are surfaces with an object casting a shadow throughout the day to indicate the time based on the sun's position relative to the shadow-casting object. The first record of a sundial in Rome is 293 BCE according to Pliny, and the dials were based on Greek sundials.[2] Dials were created primarily for the public, and most Mediterranean clocks found are from marketplaces, temples, or other public locations.[3]

When sundials first came to Rome they were not fully understood.[4] A sundial was taken from Sicily and displayed in Rome, but the dial was used incorrectly for 99 years.[5] However, this was not detrimental to the general population. Concerns for a scientific method of timekeeping arose later in the 6th and 5th centuries because Romans began wanting their clocks to pay closer attention to the cosmos and calendar.[6]

Time Increments

Romans didn't use minutes or seconds like modern times, but they did use the concept of an hour.[7] The hour was their smallest unit of time, but their hour was different than today's version of an hour. Ancient Romans adopted an Ancient Egyptian method of timekeeping by dividing the daylight and darkness into 12 increments each.[8] This method ignores the season and changing length of day. In Rome, an hour was closer to 45 minutes in winter and 75 in summer.[9] However, most clocks and dials were not detailed beyond hours according to Denis Savoie, an astronomer specializing in sundials (Figure 1).[10] Hours would tell when meeting, dinners, or other activities would be, but Roman hours would not track as closely and carefully as today.[11] Alexander Jones, curator of an exhibition called "Time and Cosmos in Greco-Roman Antiquity" at the Institute for the Study of the Ancient World in New York, comments that being 15 minutes late would not be a cause for impatience or complaining.[12]

Romans knew they were being imprecise, but there was no call to create a more accurate system until the third and second centuries BCE.[13] However, Julius Caesar in 54 BCE was said to have mentioned night hours are longer in Britain than in Rome.[14] This was demonstrated by using a water-based timepiece to show a standardized amount of time versus the variable sunlight (Figure 2).[15] Latitude differences are the main cause for this difference.[16]

Owners of portable sundials would still have a decent approximation of time in far off places including, Ethiopia, Spain, or Palestine (Figure 3).[17] This would be impressive and something to be proud of in many cultures, and the number of discovered sundials indicates they were widely used by the Romans.[18] However, some felt less impressed by the idea of increments of time in a day. In one of his plays, Plautus complains about the day being "chopped into pieces" by sundials and time.[19]

Literary References

Literature has given insights to sundials in more than just Plautus' play. In 25 BCE, the Roman author and architect Vitruvius listed all the kinds of dials and the Greek inventors in Book IX of his *De Architectura*.[20] The book uses the word "arachnen" meaning "spider's web" when referring to the hour lines cut into the stone, and this webbing was found on all types of dials listed (Figure 4).[21] The differences in his listing of types depended mainly on the surface that received the shadow, and is similar to the modern categorization of sundials.[22] Vitruvius claims that despite an abundance of information on clocks and portable clocks, building a sundial was limited to one's understanding of the celestial sphere above.[23] This lack of understanding by the general public was why timekeeping remained a luxury for the elite.[24]

Types of Timepieces

Three main types of timepieces used in ancient Roman times were the sundial, klepsydra, and obelisk.[25] Inspired by the Greeks and Egyptians, these early clocks relied upon either the sun or water.[26] Sundials and obelisks depend on the sun, but time still had an impact on the Roman people on cloudy days and at night.

Klepsydra were typically used in interiors, at night, and on cloudy days.[26] A bowl of water with a small hole in the bottom was inspired by Greek traditions in law courts, and the vessel would pour out the water over a predetermined length of time (Figure 5).[27] This practice is similar to modern sand hourglasses and functioned similar to a timer used in modern times, and klepsydra translates to hourglass.[28] Unlike the sundial, a klepsydra kept a consistent length of time despite shifting latitudes and seasons.

The Solarium Augusti is a pair of nodus-based obelisks casting a shadow on a planar surface.[29] Most obelisks come in pairs but have been separated from their neighbors over time.[30] One Solarium Augusti obelisk, called Horologium Augusti, was an ancient Roman monument built during the reign of Augustus (Figure 6).[31] Originally, the obelisk was 30-meter tall and made of red granite.[32] It had been brought from Heliopolis in Egypt, and was called the Obelisk of Montecitorio.[33] This solar marker functioned as a sundial, and acted as a gnomon casting onto marble pavement with a gilded bronze web of lines that indicated the time of day according to the season.[34] Dedicated to the Sun 35 years after Julius Caesar's calendar reform, the obelisk was placed so the shadow of the gnomon fell across the center of a marble altar on 23 September to commemorate Augustus' birthday.[35] This symbolized Augustus' control of Egypt by the Roman empire.[36]

Over time Pliny the Elder stated that the Horogium Augusti's casting had shifted and become incorrect, but it remained standing until the 8th century CE.[37] Then, the obelisk was thrown down and broken only to be rediscovered in 1512.[38] Pius VI re-erected the obelisk in Piazza di Montecitorio in 1789.[39]

The Lateran Obelisk is the largest standing ancient Egyptian obelisk in the world (Figure 7).[40] It was from the temple of Amun in Karnak and moved to Alexandria.[41] Then, Constantius II had the Lateran obelisk shipped to Rome.[42] After the fall of the Western Roman Empire, it and a neighboring obelisk fell.[43] The Lateran was re-erected in 1588 CE.[44]

Other obelisks in Rome were taken from Egypt, and others were commissioned from Egypt.[45] Although obelisks are prone to falling or being toppled down, some still exist or have been re-erected. At least eight obelisks made in antiquity by the Egyptians were taken to Rome after the Roman conquest and stand today.[46] This includes the Lateran Obelisk, its neighboring obelisk, and the Solarium Augusti obelisks.[47] An additional five obelisks stand that were commissioned by wealthy Romans from Egypt in ancient Roman times, or they were built in Rome as copies of ancient Egyptian originals.[48] Many no longer have the webbing designs needed to tell time.[49]

Vitruvius' use of the word "arachnen" in Book IX of his *De Architectura* referred to the hour lines cut into stone sundials.[50] There are four main types of sundial in antiquity: spherical, conical, plane, and cylindrical.[51] Each kind of dial has distinct differences, but all involved reading and understanding these webs drawn from paths of shadows over time. Sundials were often used in sunny weather so the shadows of the gnomon would cast but many have broken off

(Figure 8). They all have a gnomon point, but the main difference is in what type of surface the shadows travel over.[52]

Spherical dials were round shapes and came in many subtypes.[53] Hemispherical dials with central and non-central placed gnomon point exist, and they resemble bowls or domes (Figure 9). There are also cut spherical dials that look as though a slice was taken from a hollow ball or bowl (Figure 10). Quarter spherical dials look like an orange slice or a quarter of a ball (Figure 11). Roofed spherical dials are a ball of stone with a hole for a gnomon point, so a dot of light travels the path shadows would on other types of dial (Figure 12). Spherical globe dials are rounded stone resembling a ball with time indications etched into them. The Globe of Matelica was likely part of an ancient Roman sundial from the first or second century (Figure 13).[54]

Conical dials were cut in a conical slice shape with the vertex above, below, or on the horizontal top surface.[55] To picture a cone, the familiar ice cream cone is helpful to imagine. To get an idea of a vertex above conical dial, think of breaking the tip of the cone off. The outline of the cone will leave either an oval or, if done perfectly level, a circle. The vertex above conical dial was similar to the ice cream cone, but the break cuts the tip of the cone off at an angle so the entire point and part of the original ice cream hole are gone (Figure 14). The other conical types have the same idea but at different angles.

Planar sundials are dials that trace the cast shadow across a flat surface or relatively flat surface.[56] Obelisks are planar and track the sunlight on the ground for their surface. Horizontal, prime vertical, meridian, and deviating dials are all similar, but have different webbing of lines to indicate important times and the equinox (Figures 15, 16, 17, 18). Planar dials are primarily undecorated besides red paint traces found in hour lines and day curves.[57] However, some lines have been inlaid with gold, or gilded bronze.[58]

The cylinder dial was also called the shepherd's dial for the shepherds, who would trace the webbing design on their staffs.[59] Around the top of the staff would mark the months, and the shadow would cast from the gnomon point onto the long staff in a series of arches (Figure 19).[60] The point the mark lands on the arch would indicate the time that day.[61] Some cylinder dials were webbed to be read at different angles, so there are inclined cylinders and vertical cylinders.[62]

Stone sundials often had reliefs and decorative moldings added (Figure 20).[63] These designs included vines curling, rosettes, lion motifs, and stylized legs holding the dials up. Decorative additions were found on many types of sundial, but designs were rare on planar dials due to avoiding obstructing the important webs and labels that were detrimental in reading the time.[64]

One conical dial had geometric figures rather than rosettes similar to a carpenter's square (Figure 21). The shape embodies Euclid 2 definition 2 "And in any parallelogrammic area let any one whatever of the parallelograms about its diameter with the two complements be called a gnomon," so any area with four sides can be explained as a smaller quarter of the area where the point at the center creates the gnomon. (Figure 22).[65] The word gnomon comes from the Greek word meaning carpenter's square, and a carpenter's square is an L-shaped tool with its two sides at right angles.[66] Euclid's use of the word is doesn't require the sides be at right angles. The gnomon is a point of motion that creates an important shape similar to how sundial gnomon points showed a motion that indicates time, and this understanding adds another level of significance and mathematical understanding to the dial itself.[67]

An altitude sundial uses the height rather than the direction of the sun to tell the time.[68] These dials needed adjustment for the date, since the sun is higher in the sky in the summer than the winter (Figure 23). However, not every vertical dial was an altitude one; some used the shadow cast by a string and depends on the sun's direction.[69] Some designs of altitude dial were useable in any latitude with manual adjustments, but some were specific to one latitude.[70]

Portable dials offered more freedom to Roman travelers that a fixed stone ever could (Figure 24). The owner could travel while still knowing the time, but this came with difficulties beyond high expenses. The portable dials would only show half of the day, so the owner needed to know if the sun was rising or setting even during difficult times around midday.[71] Prelabeled latitude adjustment points were made to lessen the struggles of adjustment in commonly visited places, but the latitude label was not always perfect.[72] Northern latitudes were less accurate places for Mediterranean dials in the height of summer and low of winter.[73] Adjustments were manual though, so they could be corrected if the owner knew how to correct the error. However, the owner could easily make mistakes in adjustment and reading, but the owner never needed to know which way North was.

One type of portable dial, the user turned a smaller disk within a larger disk to account for latitude and turned a pointer on the smaller disk to account for the month.[74] Then they held the device on a string or chain facing the sun, and casted a shadow across hour markers on the pointer.[75] Another design was three nested rings, and the user tilted the innermost horizontal ring based on latitude.[76] Then spun the outside until a beam of sunlight could pass through a small hole to reach hour markers.[77] This model was collapsible to help with additional portability (Figure 25).[78]

Who Used Ancient Clocks

One group that utilized timepieces was the military. Military groups woke, ate, marched and slept at predetermined times. Some units were required to walk a predetermined distance every hour, and the ability to keep track of the approximate time helped the organization and pace needed to conquer and travel the ancient world.[79] To continue moving, the military often used portable sundials to keep track of the time.

Fixed sundials of stone were used in more public and permanent settings. Magistrates often paid for the construction of sundials in important political locations around their city, so sundials had a political role and connotation to them in earlier Roman times.[80]

The island of Delos in Greece was abandoned in antiquity, so it shows a relatively undisturbed site to learn about sundials (Figure 26).[81] Dials were often found in public areas, and very few dials were found in private homes.[82] Marketplaces and temples were popular locations to find fixed stone sundials.[83] However, Delos also contains a stone sundial that is out of place. The dial was made for Egyptian latitudes, so it is likely the sundial was taken from Egypt.[84]

Pompeii was also abandoned in antiquity due to the eruption of Mount Vesuvius, so the city also had good materials left from ancient times (Figure 27). However, Pompeii differs from Delos. Pompeii had many dials in private homes.[85] Most Pompeii public dials have since been moved to museums, including the Oscan cone.[86] The sundials of Pompeii were usually not of high quality and often had incorrect latitudes.[87] The large demand for personal and private dials caused a higher demand for dials than a few dials in public areas, so the quality was lowered to accommodate the demand.[88] Pompeii sacrificed precision for simpler construction.

Construction

Ancient Roman dials were often crudely constructed and set up, but the acceptance of approximation by the people made the simple and imprecise instruments acceptable.[89] However, sundials, even in antiquity, could be made exactly correct.[90] The performance of a dial relies on the fineness of the engraved lines, the attention of the observer, and their understanding of the laws of optics. Stone dials had carved lines to indicate the month and equinox because these lines depend on latitude.[91] Fixed sundials of stone were installed where they were intended to be used, so the latitude would not change on these.[92] All the types of fixed sundial were able to be made exact, but the portable sundial needs a level of approximation.[93]

The designers of portable sundials were aware of the approximations they made and were satisfied with their drawings, calculations, and trials.[94] The error in portable dials were quite small for latitudes designers intended the dials to be used in, but the error was still noticeable.[95] Designers settled for the small error to meet the demand for dials. To make these important instruments, there were workshops and craftsmen whose main job was making these clocks, and inscriptions indicate the presence of workshops with highly specialized craftsman making timekeeping devices.[96]

Inscriptions

Some of these designers and makers of sundials can be identified using inscriptions on stone dials.[97] Stone clock inscriptions were found across the Mediterranean in both Greek and Latin (Figure 28).[98] Additional languages found on sundials or fragments thought to be sundials are Greek, Latin, Nabatean, Oscan, Phoenician, and neo-Punic.[99] These inscriptions tell some names of people who made and commissioned sundials, and the inscriptions indicate places, when the dials were made, and astronomical terminology of the time.[100]

Sundials are notoriously difficult to date because the stone cannot be carbon-dated or dated by the objects around them, and adjustable dials were often found without context or rediscovered in storage.[101] The use of centuries of mathematical and astronomical work make it difficult to place dials in a specific time, but they must be younger than the concise method of writing latitude.[102] The latitude listings are significant because they show how Romans had the freedom to travel but remain connected to the Roman world. Constantinople is listed on some portable sundials as an option for latitude, so those dials can be dated to after 330 CE.[103] Romans didn't grow up with the detailed maps modern people have access to, so they had to build a picture of the world around them by traveling and learning as they went.

Romans frequently learned from other cultures across the ancient world, and they copied and improved upon technology of other civilizations. Timekeeping was developed in this way. Sundials, obelisks, and klepsydra were used by the elite and public to tell and keep track of time in their growing and organized society. Knowing the time based on the true motion of the stars, Earth, and Sun is something often glossed over when modern people ask for the time. Time can be known in an instant without going to a marketplace or fiddling with dials, but it wasn't always so simple.

Endnotes

1. George Cupcea, “Timekeeping In The Roman Army,” The Hour Glass, Published 07.07.2018.
2. Meghan Bartels, “Early Tech Adopters in Ancient Rome Had Portable Sundials,” Smithsonian.com.
3. Cupcea.
4. Ibid.
5. Ibid.
6. Ibid.
7. Ibid.
8. Bartels.
9. Ibid.
10. Ibid.
11. Ibid.
12. Ibid.
13. Cupcea.
14. Ibid.
15. Ibid.
16. M. T. Wright, “Greek and Roman Portable Sundials: An Ancient Essay in Approximation,” *Archive for History of Exact Sciences* 55, 2000, Pages 177-87.
17. Bartels.
18. Wright, Pages 177-87.
19. Sharon L. Gibbs, *Greek and Roman Sundials,* Yale Studies in the History of Science and Medicine, New Haven, Yale University Press, 1976, Pages 59-65.
20. Ibid.
21. Ibid, Page 60.
22. Cupcea.
23. Ibid.
24. Ibid.
25. Ibid.
26. Ibid.
27. Ibid.
28. Ibid.
29. “World of Obelisks: Rome,” PBS, Public Broadcasting Service, Nov. 2000.
30. Ibid.
31. Carlos F. Noreña, “Locating the "Ustrinum" of Augustus,” *Memoirs of the American Academy in Rome* 58.
32. Ibid.
33. Ibid.
34. Ibid.
35. Ibid.
36. Ibid.
37. Ibid.
38. Ibid.
39. Ibid.
40. “World of Obelisks: Rome.”
41. Ibid.
42. Ibid.
43. Ibid.
44. Ibid.
45. Ibid.
46. Ibid.
47. Ibid.
48. Ibid.
49. Ibid.
50. Gibbs, Page 60.
51. Ibid, Pages 12-58.

52. Ibid.
53. Ibid, Pages 12-30.
54. Ibid, Page 27.
55. Ibid, Page 30.
56. Ibid, Page 39.
57. Ibid.
58. Ibid.
59. "Time from the height of the sun," History of Science Museum.
60. Ibid.
61. Ibid.
62. Gibbs, Pages 56-58.
63. Ibid.
64. Ibid.
65. Ibid.
66. Ibid.
67. Ibid.
68. "Time from the height of the sun."
69. Ibid.
70. Ibid.
71. Bartels.
72. Ibid.
73. Ibid.
74. Ibid.
75. Ibid.
76. Ibid.
77. Ibid.
78. Ibid.
79. Cupcea.
80. Ibid.
81. Gibbs, Pages 90-92.
82. Ibid.
83. Ibid.
84. Ibid.
85. Ibid.
86. Ibid.
87. Ibid.
88. Ibid.
89. Wright, Pages 177-87.
90. Ibid.
91. Gibbs, Pages 12-58.
92. Bartels.
93. Wright, Pages 177-87.
94. Ibid.
95. Ibid.
96. Cupcea.
97. Gibbs, Pages 85-88.
98. Cupcea.
99. Gibbs, Pages 85-88.
100. Ibid.
101. Bartels.
102. Ibid.
103. Ibid.

Bibliography

Bartels, Meghan. "Early Tech Adopters in Ancient Rome Had Portable Sundials." Smithsonian.com. Published 02.20.2017. https://www.smithsonianmag.com/innovation/early-tech-adopters-ancient-rome-had-portable-sundials-180962225/#pzM1LYjhXOuZmpYI.99. Accessed 02.14.2019.

Beaver, Donald DeB. "Review on *Greek and Roman Sundials* by Sharon L. Gibbs." *Isis* 70. 1979. Pages 173-75. http://www.jstor.org/stable/230903. Accessed 03.03.2019.

Cupcea, George. "Timekeeping In The Roman Army." The Hour Glass. Published 07.07.2018. https://www.thehourglass.com/cultural-perspectives/timekeeping-in-the-roman-army/. Accessed 02.14.2019.

Gibbs, Sharon L. *Greek and Roman Sundials*. Yale Studies in the History of Science and Medicine. New Haven. Yale University Press. 1976.

"Time from the height of the sun." History of Science Museum. http://www.mhs.ox.ac.uk/collections/imu-search-page/narratives/?irn=3237&index=0. Accessed 02.08.2019.

"World of Obelisks: Rome." PBS. Public Broadcasting Service. Nov. 2000. www.pbs.org/wgbh/nova/egypt/raising/rome.html. Accessed 03.03.2019.

Wright, M. T. "Greek and Roman Portable Sundials: An Ancient Essay in Approximation." *Archive for History of Exact Sciences* 55. 2000. Pages 177-87. http://www.jstor.org/stable/41134104. Accessed 03.03.2019.

Noreña, Carlos F. "Locating the "Ustrinum" of Augustus." *Memoirs of the American Academy in Rome* 58 (2013): 51-64. http://www.jstor.org/stable/24616456.

Wind, Geraldine Dunphy. "Sant'Andrea Al Quirinale and the Sundial." *Source: Notes in the History of Art* 32, no. 2 (2013): 19-26. http://www.jstor.org/stable/23292908.

List of Illustrations

Illustrations

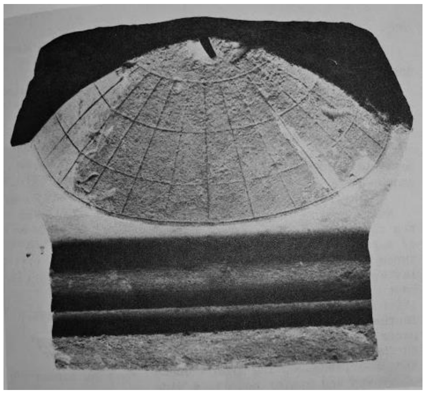

Figure 1. Hour Lines on Conical Sundial.

Figure 2. Karnak Klepsydra.

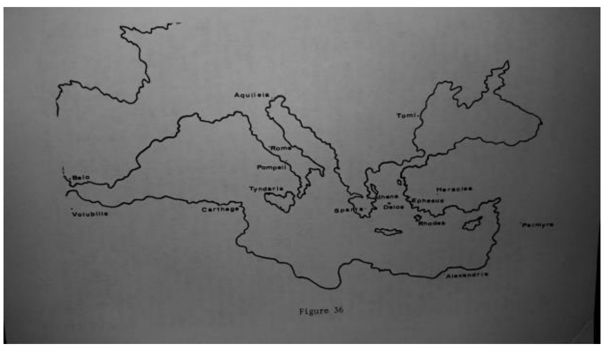

Figure 3. Map of Mediterranean.

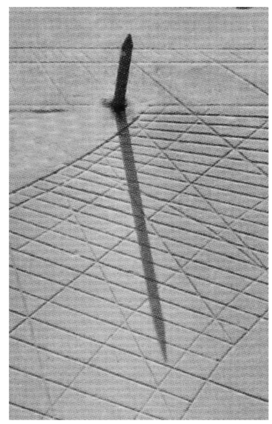

Figure 4. Sundial Webbing.

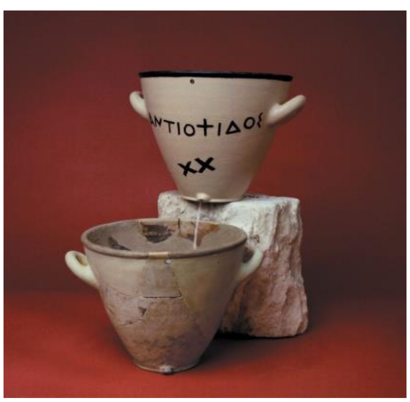

Figure 5. Klepsydra.

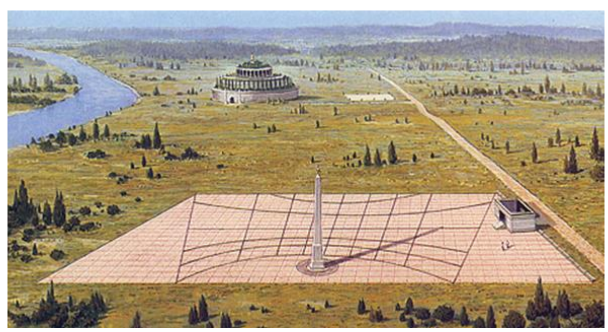

Figure 6. Horologium Augusti.

Figure 7. Lateran Obelisk.

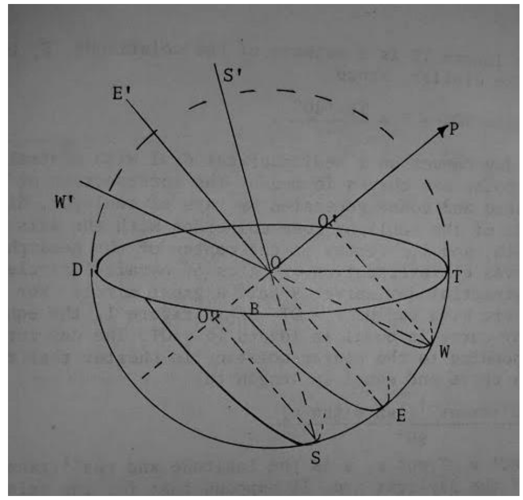

Figure 8. Gnomon Point O.

Figure 9. Hemispherical Sundial.

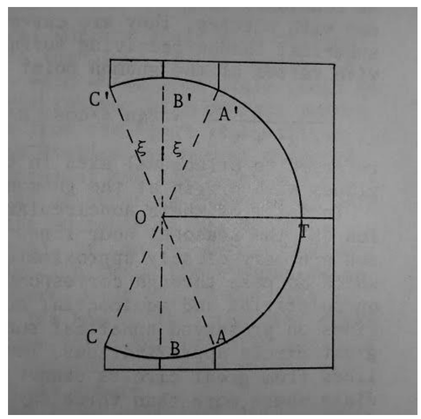

Figure 10. Cut Spherical Line Drawing.

Figure 11. Quarter Spherical Sundial.

Figure 12. Cadran Solaire Roofed Spherical Sundial.

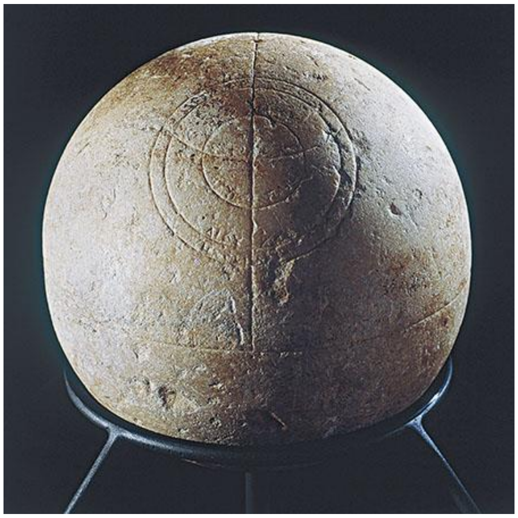

Figure 13. Globe of Matelica.

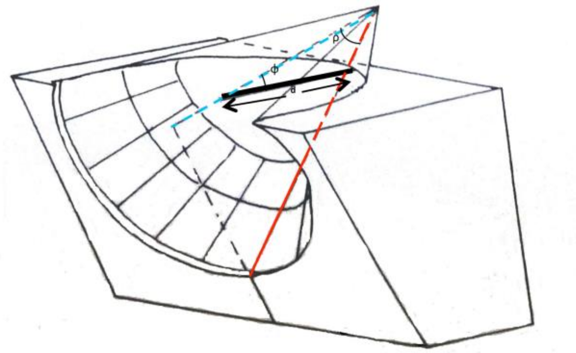

Figure 14. Conical Dial Line Drawing.

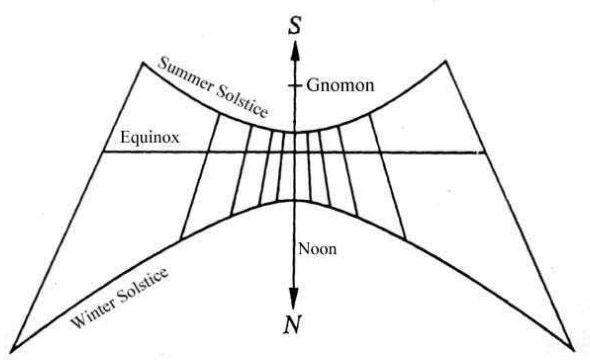

Figure 15. Planar Horizontal Grid.

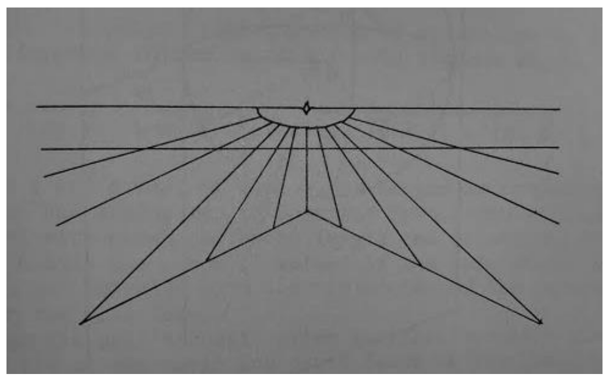

Figure 16. Prime Vertical Grid.

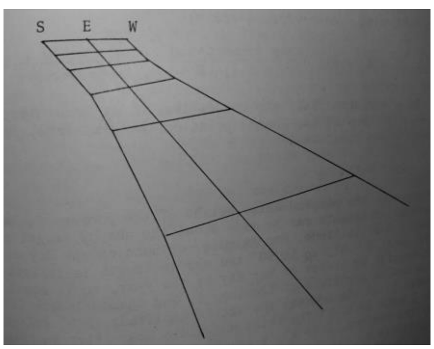

Figure 17. East Face of Prime Meridian Dial Grid.

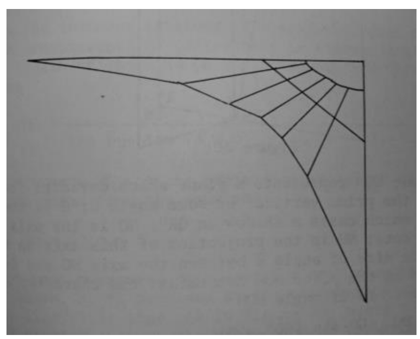

Figure 18. Deviating Dial Grid.

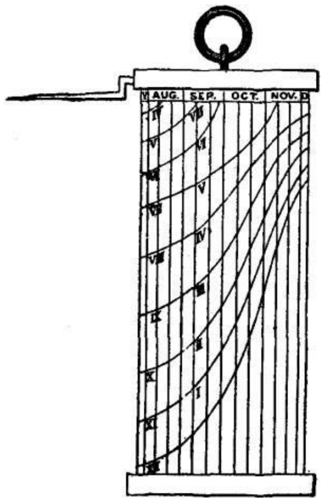

Figure 19. Cylinder Sundial.

Figure 20. Sculptural Spherical Sundial.

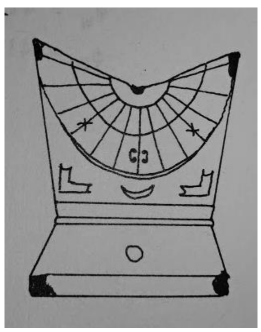

Figure 21. Carpenter's Square Conical Sundial Line Drawing.

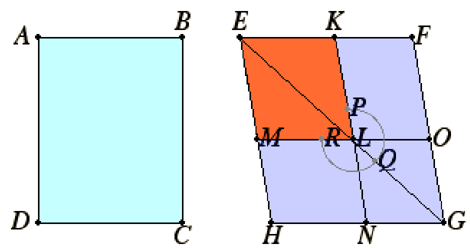

Figure 22. Euclid's right-angled parallelogram.

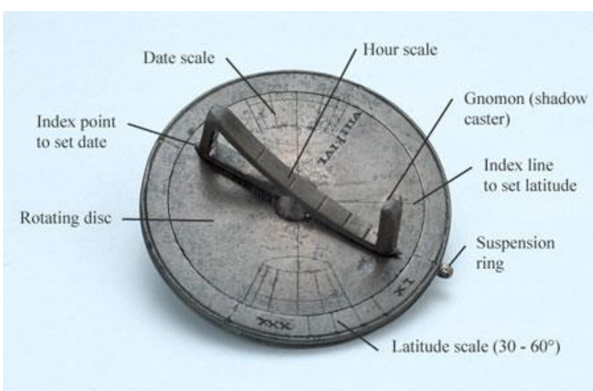

Figure 23. Portable Sundial with Markings.

Figure 24. Portable Sundial.

Figure 25. Nested Ring Sundial.

Figure 26. Delos.

Figure 27. Pompeii.

Figure 28. Inscribed Sundial.