3 Conclusion: Development of the Twelve- and Ten-Part System of Architectural Spacing

A synthesis of my findings from examination of the excavated sites and of the classical literature makes possible the following conclusions.

Although my study was confined to examples of large open spaces for public use, I believe it can be safely inferred that the ancient Greek system of architectural spacing was universally employed, not only in the formation of urban spaces, whether on a large or small scale, but also in the disposition of statues and other decorative elements.

Aristotle contrasted the new Hippodamian system (*νεώτερος καί ἱπποδάμειος τρόπος*), or grid-iron plan, for organizing the layout of a city with the traditional system (*ἀρχαιότερος τρόπος*).[1] Prior to the use of the Hippodamian system (fifth century B.C.) all cities had been laid out in accordance with this traditional system, and they give the impression (as in Athens, for example) of having no comprehensive plan. But, when Aristotle contrasted the new system with the old, he was actually comparing two "systems," not a new system with previous haphazard growth. And it is possible to assume that the system of planning I describe here is that "traditional system" to which Aristotle referred.

Origin of the System

The traditional system was devised to bring order into the disposition of buildings in a layout just as Greek philosophy brought order into the cosmos: the ordering of space on the earth would mirror the order of the universe.

As revealed in their writings, one of the most profound beliefs of the ancient Greeks was that man was "the measure of all things." This concept was given visible expression in the organization of the human environment: man himself was the center and point of reference in the formation of architectural space.

The ancient Greek writings also show the strong influence of mathematical laws on everyday life and thought. A mathematical image of the universe was taught by all philosophers. Proportion, or harmony, was considered of great importance and was used in every sphere. Thus, it might be expected that the buildings of ancient Greece would be disposed in space according to mathematical laws. The inherent logic of their siting was recognized by each succeeding generation, so that the harmonious development of the layout was ensured. The architects continued to follow the accepted theories of proportion, based at first on arithmetic and later on geometric principles. Certain practical considerations, however, such as the physical nature of the site and other technical exigencies, also affected the development and use of the system.[2]

Each site was divided into sectors, allowing for extensions within the over-all plan. The placing of the buildings was directly related to the contours of the landscape, because the Greeks continually sought to achieve order in space, no matter whether the space was natural or man-made. For example, when seen from the main entrance to the Altis at Olympia, at the southeast corner of the site, the outline of the Hill of Kronos, to the right, formed an essential balance with the temple of Zeus to the left (see Figure 40).

Since buildings were oriented according to

their relative position in space, the effects of optical perspective were important. (Parallel lines, for example, give the effect of diminishing space, open angles of magnifying it.) The effects of different shapings of space were studied (see Euclid's *Optica*), and the lines of buildings were brought into harmony with each other and with the landscape. The ancient Greeks wished to see for themselves the rising and setting of the sun; hence the sectors of the site leading east and west were usually kept open. It was man himself—not the god in the temple—who was the measure of all things.

As shown in the preceding chapters, there were certain differences between the Ionic and Doric sites. Although the small number of examples available for study makes it impossible to give definite reasons for these differences, a tentative explanation can be put forward, which is based on the contrasts between the Ionic and Doric views of the universe. The Ionians considered space to be infinite, and, since they feared endless space, they always enclosed the views in their layouts. The Ionians also favored the number 10, and it was fundamental in all their planning. It appears that they did not employ a different mathematical system for each god but used a single system based on the number 10. On the other hand, all other Greeks, both on the mainland and in the western colonial settlements, considered space to be finite and bounded. They had no fear of infinity, and their layouts always included a definite route that traversed the entire site and opened to the outside world. They divided space into twelve parts. According to the Pythagoreans, the universe was based on the equilateral triangle. Archytas refers in his *Harmony* to the dominance of angles of 30°, 60°, 90°, 120°, etc.[3] Although there are examples of numbers associated with the gods, there are too few to demonstrate positively whether certain mathematical systems were consistently associated with certain divinities.[4]

The development of the ancient Greek system of planning can be traced from the seventh to the first century B.C. It came into being with the birth of Greek architecture, reached the height of its development during the golden age of Greece, and fell into disuse when Greece declined. Its tradition was carried on in Hellenistic Asia Minor. A brief chronology of the development of the system follows.

Seventh Century B.C.
Concepts of the universe were still unclear. There were myths, but there was no philosophy; there was epic poetry, but no history. Site planning did not yet exist.

Sixth Century B.C.
Philosophy had its beginnings in Ionia, and there was interest in the laws governing the universe. In Miletus, Anaximander expounded his mathematical theory of the universe. The first observations were made of architectural space.

Ionic Order. The Heraion at Samos (Fig. 70), at the time of the second hecatompedon, represents possibly the first conscious attempt of the Greeks to organize space. About 550 B.C. the architects Rhoikos and Theodoros prepared the plan for the sacred precinct of Hera on the basis of the number 10, that is, dividing the space into ten parts.

Doric Order. The sacred precinct of Demeter at Selinus (Fig. 112) shows a full application of the twelve-part system of organizing space without use of the corresponding angles. Possibly the 90° angle was used.

530 B.C. Acropolis I at Athens (Fig. 3) represents the first known application of the twelve-part system on the Greek mainland. There is a balance of the major perceptible elements. Specific angular measurements were apparently not used. An arithmetical progression is observable along the length of the plan.

After 530 B.C. At the terrace of Apollo at Delphi (Fig. 8) the space was divided into twelve

parts. The first observed use of the 60° angle was made here.

Ionic Order. End of sixth century B.C. In the reorganization of the Heraion at Samos the division of space into ten parts was continued from the earlier layout.

Fifth Century B.C.

Doric Order. Circa 480 B.C. At the Acropolis II at Athens (Fig. 4) and the sacred precinct of Aphaia at Aegina (Fig. 19) the same mathematical system was used: twelvefold division of the area; the equilateral triangle was employed, with its sides divided into three equal parts.

479 B.C. At Delphineion I at Miletus (Fig. 23) there was twelvefold division of the area; the equilateral triangle was used, with its sides divided into two equal parts.

470–430 B.C. At the Altis at Olympia the sacred precinct of Poseidon at Sounion (Fig. 52), and Acropolis III at Athens (Fig. 5) the same system was used: twelvefold division of the area; the equilateral triangle was employed, with its sides divided into two equal parts.

Fourth Century B.C.

Ionic Order. 350 B.C. The Asclepeion at Cos (Fig. 77), the sacred precincts of Demeter (Fig. 120), and the agora at Priene (Fig. 84) show a tenfold division.

Doric Order. 334 B.C. In the reorganization of the Delphineion at Miletus (Fig. 24) the twelvefold system was retained.

Third Century B.C.

Doric Order. The agora at Pergamon (Fig. 56) shows a twelvefold division.

Ionic Order. 300–250 B.C. In the reorganization of the Asclepeion (Asclepeion II) at Cos (Fig. 77) and of the sacred precinct of Zeus at Priene (Fig. 93) a tenfold division was used. The sacred precinct of the Egyptian gods at Priene (Fig. 121) shows an eightfold division.

Second Century B.C.

Doric Order. At the sacred precinct of Athena at Pergamon (Fig. 61) a twelvefold division was employed.

Ionic Order. 160 B.C. The upper terrace of the Asclepeion at Cos (Fig. 77) and the sacred precinct of Artemis at Magnesia (Fig. 94) are the first two examples of an axial site plan.

Doric Order. The Altis at Olympia (Fig. 39) was reorganized to give more sense of enclosure.

Roman Period

Ionic Order. The axial layout of Palmyra (Fig. 106) clearly follows the Hellenistic tradition.

Aesthetic form was created by man to give pleasure to man. Pains were taken to place each structure and each group of structures to the utmost perfection so that they could be enjoyed from every viewpoint. Every detail was important: roof tiles, which would be seen by no one, had to be finished with the same care as the columns of a portico.

The ancient Greek system was total. It took all space into account, and all three-dimensional masses, man-made or natural, were incorporated as volumes in space. Voids as well as masses had their form, since together they constitute architectural space—the space that is created by man to enhance his sense of well-being.

Summary

It has been shown in Chapter 1 that the ancient Greek system comprehended certain basic tenets.

1

The relations between buildings had to be as simple as possible so that there would be the fewest possible lines in man's angle of vision. This principle extended to every detail.

2

Since gaps break the continuity and create a sequence of different elements rather than a coherent whole, care was taken to leave no optical gaps between buildings and to place them so that the line of one structure was directly con-

tinued by the next. For the same reason an effort was made to compose the outlines of the different buildings into a unified silhouette.

In every layout man was the focus of the creation. All sight lines started from man's position in space; all angles of vision were measured from the turning of his eyes; the length of his view decided the direction of the sacred way (looking toward the sunrise or out over the natural landscape); his height (that is, the level of his eyes) determined the line of horizontal perspective; his foot was the measuring rod for the length and breadth of all buildings. Space was created by man for man.

In Olympia, for example, the outline of the temple of Zeus is continued in one view by the Nike of Paeonios (Fig. 40), and in another view (Fig. 48) the line of the temple is continued to the left by the Hill of Kronos and the propylon and, to the right, by the Nike again.

3

The governing principle was that each form should be not only distinct but also visible in its entirety: from each viewpoint a building should either be seen as a whole or be excluded from the picture. No building could be obstructed so that it emerged only partially from behind another structure; nor could the continuation of a building be hidden from view. Adherence to this law was universal. One finds in every grouping that a building comes into view at the point where the view of another building ends. Precision and clarity were all-important elements in the formation of space. The sizes of the various buildings visible at any one time, as well as the spaces in which they stand, appear to man's eye in simple ratios such as 1:2, 1:2:1, 2:1:2, 1:1:1, 2:3:2:3. Space is always partitioned harmoniously. The total mass of each structure was calculated and its effect determined. At times, as for example in the sacred precinct of Aphaia at Aegina (Fig. 19), these even appear to form a symmetry, which did not exist in reality.

The organization of every site was entirely rational and could be immediately comprehended from the entrance. The visitor's eyes were led to the most significant goal (usually an altar), which was approached by a clearly visible pathway, free of structures. But no organized routes led to the different buildings, nor was the site dominated by its largest structure. Every form was distinctly visible, and the visitor was at liberty to choose his own way. The entire layout was directly related to the landscape, and its design followed natural laws.

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[1] *Politics* 7.10.4.

[2] [For information on construction methods in ancient Greece see Roland Martin, *Manuel de l'architecture grecque,* Paris: Picard, 1965, and Anastasios K. Orlandos, Τά ὑλικά δομῆς ἀρχαίων Ἑλλήνων, 2 vols., Athens: Library of the Archaeological Society, 1955–1960. The latter has been published in French under the title *Les matériaux de construction et la technique architecturale des anciens grecs,* trans. V. Hadjimichali, 2 vols., Paris: De Boccard, 1966.]

[3] Andreas Speiser, ed., *Klassische Stücke der Mathematik,* Leipzig: Orell Füssli, 1925, p. 9.

[4] [It is known that the most significant dimensions in the temples of ancient Greece always corresponded to round numbers of Greek feet. The author sought to determine whether this principle also applied in the Greek organization of exterior space. In taking measurements on the sites, the author used the following foot lengths:

Attic foot = 0.328 m
pre-Periclean foot = 0.308 m
Ionic foot = 0.349 m
Egyptian ell = 0.524 m.

Although the measurements of all important distances were checked according to these scales, the tables (pp. 9–14) record only the instances where the author was able to establish a definite correspondence with round numbers such as 100, 150, or 200 feet. In four cases the author was unable to examine the sites himself and was obliged to work from small plans that did not permit very detailed study.

There is still no complete accord on the size of the "foot" used in ancient Greece. The lengths used in this work differ somewhat from those given by W. B. Dinsmoor (in *The Architecture of Ancient Greece,* London: Batsford, 1950), the most widely accepted authority on the subject. Dinsmoor does not mention the existence of a pre-Periclean foot; he gives the Attic, or Doric, foot as varying from 0.326 m to 0.3272 m but states that "the Athenian foot was never quite so large as 0.328 m" (p. 195). He also gives the Ionic foot as 0.294 m, based on evidence from Didyma, "our most trustworthy source of in-

formation for the length of the Ionic foot" (p. 222). This is much smaller than the measurement accepted by Doxiadis. It is interesting to note, however, that 0.294 m was derived from "an axial spacing of 3.528 m" (p. 222), which is not far off ten times Doxiadis' unit of measurement (0.349 m). Dinsmoor also refers to the "Samian foot (so-called) of 13 7/8 inches," which is almost exactly 0.349 m. But Dinsmoor adds "this unit is very hypothetical" (p. 137). The question remains open, and several authorities (ranging from Hans Schleif to Stirling Dow) have been tempted to believe that the exact length of the foot was more or less arbitrarily determined on each site.]

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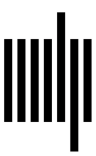

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