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## GENOTYPES OF SPATIAL FORM IN THE ARCHITECTURE OF THE EAST

The civil and religious buildings of the Central Asian peoples developed historically through a complicated interweaving of local traditions of architecture and construction with cultural influence from both neighboring and distant countries that varied according to their economic, military, political, or religious superiority. Architectural studies in the Soviet Union (A. Iu. Iakubovskii, V. A. Shishkin, G. A. Pugachenkova, L. I. Rempel, L. S. Bretanitskii, and others) have already accumulated a significant body of research that clearly reveals that the view some Western art historians of Arab architecture have put forth, namely that there is such a thing as a single, unified "Arabic" or "Islamic" architecture, is groundless. At the same time, however, when one considers the similarities in social structure and the magnitude of the cultural connections established from the seventh century onward in the countries of North Africa, the Near East, and Inner Asia where feudal relationships and the religion of Islam prevailed, one cannot deny that these factors played a synthesizing role in the formation of architectural ideas and planning decisions about public-building types.<sup>1</sup>

The present survey encompasses Afghanistan, Iran, Iraq, Syria, Palestine, Egypt, Algeria, Tunisia, and Morocco, in addition to the territories of Central Asia. This has been done in part because it is important to trace the origins of constructions in mosques and other building types, examples of which might be better preserved in places outside the borders of Central Asia, and partly to be able to demonstrate the internalized structure-forming principles that unite them and that are best revealed when one casts a wide chronological and territorial net.

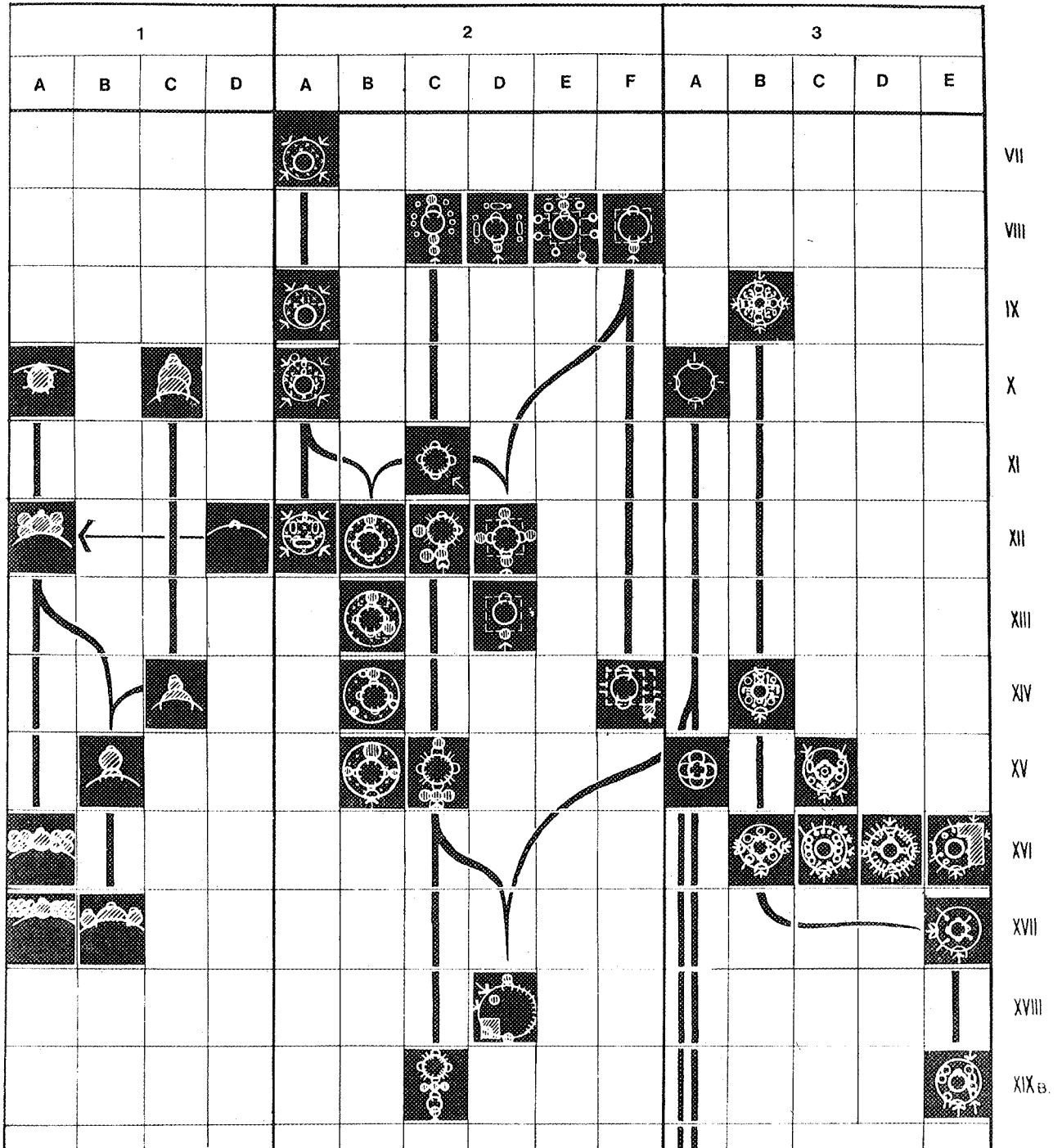
The topology of buildings and their construction can establish the line of transmission for ideas about the organization of the volumetric layout of monuments according to their functional and operational qualities. The approach that will be proposed here emphasizes the relation between spatial layout and general function, i.e., how different schemes attract or distribute

people through the way they construct zones and foci of attraction. These foci of attraction will here be referred to as "focal points." Examples are mihrab niches, pools (*ahwaz*, sg. *hauz*) surrounded by trees, iwans, and other micro-environments intended for rest, socializing, or religious services. A single type of monument, for example, the neighborhood mosque, can be categorized according to the number, significance, and placement of the focal points it possesses.

The topology of architectural space can be graphically illustrated using a method that involves the analytical modeling of its geometry of space and component parts and of the character of their relationship, both to each other and to the external environment. This can be done by making a schematic plan of the monument; in doing this we used a circle or ellipse to represent a closed courtyard, an arc inside a circle to represent an open courtyard, hatching for a covered niche or iwan, a dotted line for a skylight, an arrow for an entrance, and so forth. The code presupposes a typology that governed decisions in the vertical line on the scheme represented in figure 1, derived from what is characteristic of the architecture of the East in the "preindustrial" period.

The language of graphic symbols is also indispensable for examining the central concept of space formation—the idea that a monument is an organism having a nucleus (whether open or closed) and its framing (whether permeable or impermeable), which is often of a very different type. Such a model can provide information about the most essential features of the anatomy of a particular monument as it occupies space, and often about a group of monuments having the same topological character. It also allows one visually to identify the basic features of the structure's development, in a manner similar to the phenomena seen in the cellular growth of living organisms.<sup>2</sup>

Figure 1 arranges in tabular form some representative monuments translated into the language of the topology of space and its functions in terms of its focal



1. Topology of architectural space. Some representative monuments translated into the language of topology are placed on vertical lines representing centuries (from the 7th to the 19th, reading from top to bottom) and on horizontal lines according to three basic classes of spatial structure. Reading from left to right these are (1) structures with open layouts; (2) structures built around open spaces; and (3) closed structures. The vertical columns within these three classifications are scaled from left to right showing increased complexity.

points. The vertical lines represent centuries (from the seventh to the nineteenth reading from top to bottom); the horizontal lines distinguish the three basic classes of spatial structure: (1) structures with open layouts; (2) structures built around open spaces; and (3) closed structures. Within these classes, monuments are classified according to the number and significance of their focal points, scaled from left to right according to increasing size and complexity. Gaps in the lines of development occur either because the pertinent monuments are no longer extant or because they add nothing new to the original prototype.

From this tabular rendering, the following characteristics of the evolution of spatial structures can be extracted: (1) by comparing several horizontal lines, the number and variety of structures on each line, i.e., in a single century, show shifts in the structures that predominated and evolution of ideas about space; (2) the vertical lines from top to bottom indicate qualitative changes—in structural kinship, the formation of genotypes, and the penetration of influences into collateral branches—occurring over time; and (3) the two together show the comparison of building functions, tectonics, and the structural-genetic lines in which they appear.

The eighth, ninth through twelfth, and fifteenth through sixteenth centuries were the three periods of most vigorous development, but the greatest number of essentially new structures date from the eleventh and twelfth centuries. Research data also reveal that this same period shows a rapid growth of cities and a flourishing of crafts and commerce which account for the improvement of architectural construction and the appearance of new types of buildings—ribats, caravan-sarais, khanqahs, madrasas, and mazars (places for pilgrimages). The predominance of baked brick encouraged the development of spectacular, geometrically complex systems of surface covering, usually over entire rooms, and the monumental decorative trim of exterior surfaces.

The architecture of Uzbekistan from the late fourteenth through the fifteenth century is justly regarded as representing the culmination of the achievements of Central Asian feudal architecture. Based on several examples of mosques and mausolea in Isfahan and Samarqand judgments about the composition of large architectural complexes and the trend toward enriching the typological qualities of detached buildings and structures can be made. There the exterior vaulted dome forms played an unprecedented role. Together

with a series of minarets they are included in the composition of courtyards and squares of the arcaded (*qosh*) madrasa type. The dome of the mausoleum of Gur Amir is 11.5 m. across at its base and rises to 40.0 m., and the courtyard portal arch of the principal mosque at Bibi Khanim has a span of 18.0 m. and reaches a height of 42.0 m. In structure and plan, however, the conventional mosques, mausolea, and madrasas of the fifteenth century show insignificant changes over earlier ones, amounting essentially to a more pronounced symmetry of architectural forms, the accentuation of the main axis, and a more elaborate plan.

In the sixteenth century, in complexes with a central closed space attempts were made structurally to connect the surrounding rooms with the central hall—a move in the direction of an organic connection between the interior of a building and its environment. For this purpose original gallery systems and decorative half-domes open to the outside were worked out, which placed still greater emphasis on the image of the courtyard as a living space. Finally architects and designers went on to combine the khanqah type of building (a large hall) with an L-shaped iwan, as, for example, in the mosque of Khoja Zaynuttin at Bukhara.

In the late feudal period (seventeenth through nineteenth century) in Uzbekistan, one sees in the architecture side by side with the blind imitation of precedents some rationalistic attempts to connect architecture with the life of the city. Although changes in what were fundamentally ordinary buildings are barely noticeable, the development of decorative, contrasting combinations of brick fragments and geometric grid systems continued. In the nineteenth century particularly, the pragmatism of architectural thinking did not preclude enriching spatial determinations with plastic art, and though it did not break with the artistic ideas of the preceding period, it combined them with the creative activity of popular art. This stratum of culture continues to this day in the old cities of Tashkent, Samarqand, and Khiva, though in different social manifestations.

The evolution of ideas about space from the seventh to the sixteenth century involved the loss of the "solidity" of the nucleus, the strengthening of connections between the rooms that surround the nucleus and external space, and the accentuation of the building's main axis. From the seventeenth to the nineteenth century, patchwork-like plans—the result of the decadence of older complete structures—predominated. In the complexes of this time one can observe the further

“uncovering” of spatial forms, the maximizing of contacts between focal points and the external environment, and a liberalization of the ways used to open them up. Anachronism—madrasas and mausolea built in fifteenth- or sixteenth-century style—is also characteristic of the period.

Analogous processes also occurred in the structure of the Central Asian city and in its spatial framework.<sup>3</sup> The integrity and deductiveness of the idea of an inner-core organization that governed urban space were characteristic of the seventh and eighth century. In the ninth century to accommodate large monuments the city underwent organic changes that resulted in the formation, first in the city center, then on its periphery, of one or several independent nodes that created a ring around the city's nucleus. Between the fourteenth and the nineteenth century, the stabilizing influence of the nucleus at the center and the hierarchy of zones and lines of communication and the strengthening of ties with the city's environs generated a branching centrifugal-centripetal system of spatial ties which nonetheless still maintained the orientation toward the main gate of the city. The process of understanding this environment grows out of an awareness that its complicated structure proceeds by stages along arteries and nodes toward focal points. The latter are both centers of attraction and points of orientation.

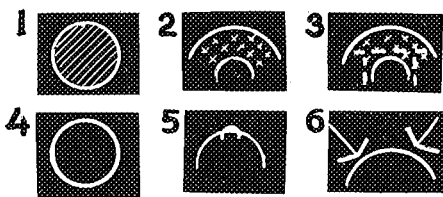
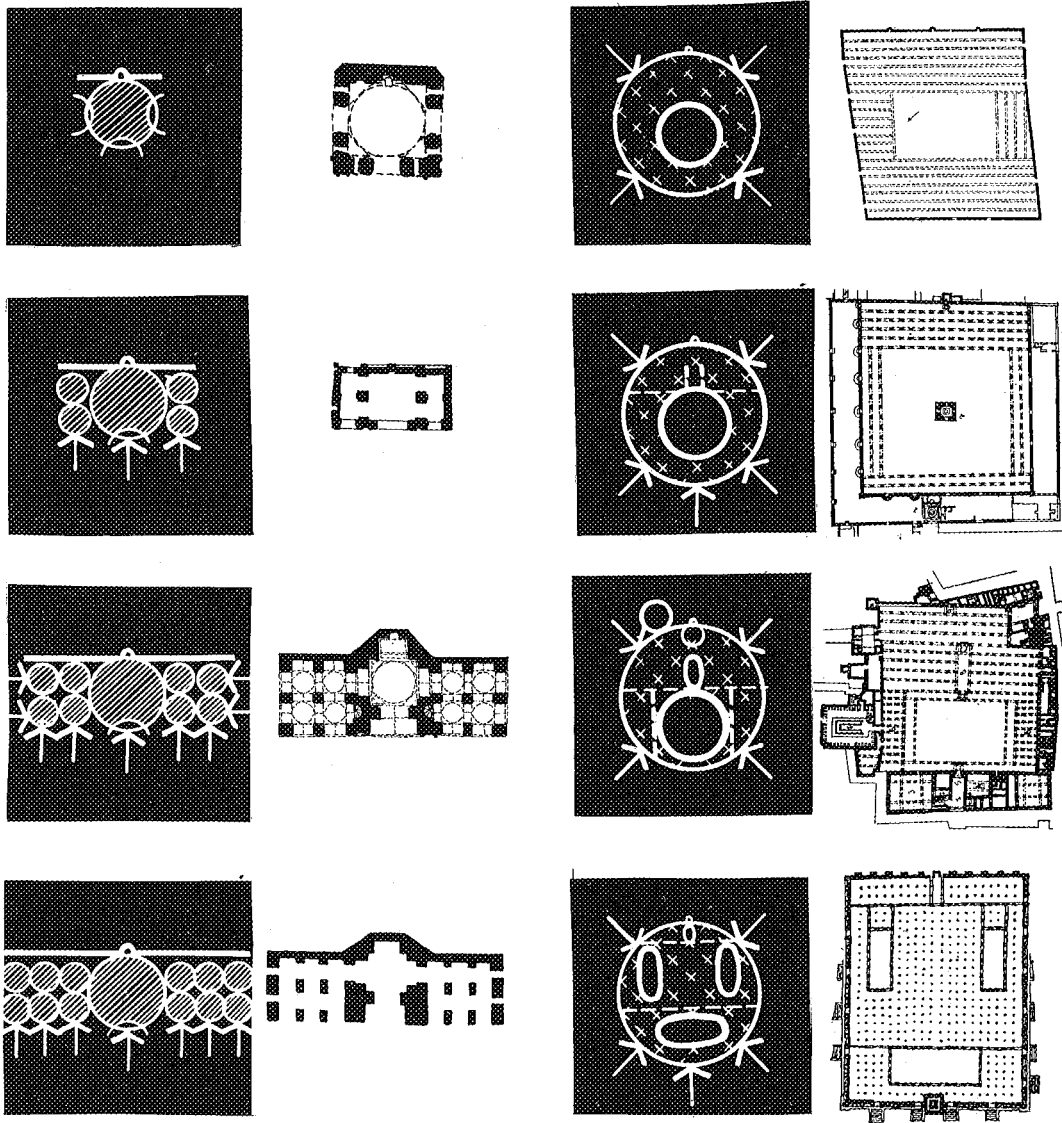
The representational arts confirm the omnipresence of these attitudes toward space. One can see in representations of space in Persian miniatures, even in the relatively brief period of time between the fourteenth and the seventeenth century, decisive transformations in medieval Central Asian spatial forms: the “field of action” in the oval central area runs over into sinuous space, breaks up, and becomes fragmented.<sup>4</sup>

The complex mechanism involved in reorganizing typical spatial structures between the seventh and the nineteenth century can be seen by looking at several adjacent lines of structural development in the vertical divisions of figure 1. The complexes that do not have courtyards with dominating covered spaces are not rich in variations and new formations. The single-domed space that originated in the mausolea of the Samanids and Arab-Ata in Tim in the eighth and ninth centuries did not change until the late fourteenth and early fifteenth centuries when architectural thought worked out more sophisticated constructions under the dome, a system of illuminating the interior, and enhancing the silhouette of the building.<sup>5</sup> Then with the appearance of intersecting arches (e.g., in the mausoleum of Chupan-

Ata in Samarqand) in the fifteenth century, the interior space is vastly improved in both formation and structure; it becomes both more capacious and more systematic. At that point development of single-domed spaces essentially ceases, because the placing of deep pylons for bearing the stress from intersecting arches, with clerestories providing light, is fully compatible only with many-domed structures with galleries or chambers encircling the central dome. Precisely because of this, structures such as the mausolea of Aq-Saray and Ishrat Khan in Samarqand appeared in the 1460's. The influence the tectonics of the dome has upon the intersecting arches in the layout of monuments can be seen in buildings such as the khanqah of Mir Said Bahrom, Bahauttin, and the famous domed markets of Bukhara.

The lines of structural kinship we have traced led in the seventeenth century to works of the type of Khoja Abdi Birun, in which two different approaches to placing the second focal point—connecting them to the outside or connecting them only with internal space—are used. Covered central spaces lose their potency in the late medieval period, but continue to be used as articulated interior offspring within the framework of the asymmetrical courtyard. Both theoretically and practically, lines of development that involved open space around which constructions were added were much more productive.

The early (seventh-century) mosques reflect a concept of unified space composed of many-columned galleries set parallel to the walls, with a large opening left in the center for light (fig. 2). In the period between the eighth and the twelfth century, this unified space was gradually broken up into a series of conventional, clearly defined zones (e.g., in the mosques of Ibn Tulun and al-Azhar). These zones are formed by changing the rhythm of the galleries, accenting some of the rows of columns, and using clerestories to provide light by cutting out part of the ceiling. The building is more deliberately oriented toward the mihrab, developing a system of volumetric and spatial signals. By the twelfth century the courtyard space is individualized by the architecture of its façades, and the main axis coinciding with the qibla is emphasized by the proportions of the courtyard and the position of the minaret opposite the mihrab. The mosque at Rabat (twelfth century), whose four skylights in the main covered space (the central one larger than the others) and several dividing lines of columns, represents the most extreme breaking up of unified space and essentially the



2. Development of space in the mosque through the centuries.

disintegration of this line of structural formation. The Friday mosque at Khiva (eighteenth century) represents a late interpretation of an archaic tradition.

Thus the "genetic age," the development of a new quality in the sequence of historical selection of the better and the more progressive type, is one of the most important criteria for the contemporaneity of architectural works belonging to this family. In the history of the architecture of Central Asia, the construction of significant public buildings using models from two or three centuries earlier was a common phenomenon. The Kalyan mosque in Bukhara, for example, built in the sixteenth century, uses a layout common to mosques of the twelfth, even though it came after the mosque of Bibi Khanim in Samarqand.

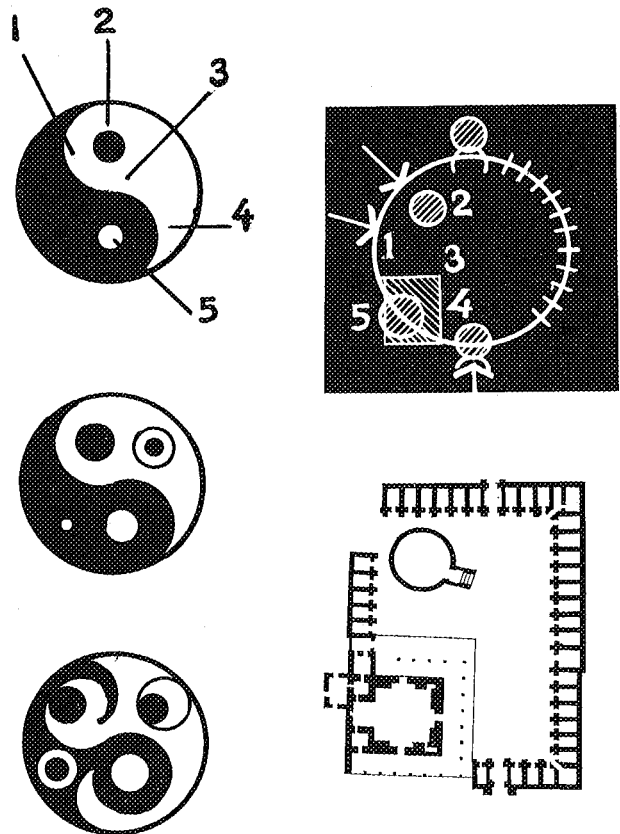
In the great mosques of Isfahan (ninth to fourteenth century), Herat (thirteenth century), and Samarqand (fourteenth century) ideas of unified space were transformed under the influence of the multiplication of the signs of the qibla and the use of four iwans in the courtyard composition (which had already taken place in the twelfth century, as in the mosque in Zavareh). When they are arranged in chronological sequence, these monuments show the continuation of the process whereby a space containing many columns is separated into zones and the rooms which are connected to the courtyard by the iwan are arranged along the main axes, an arrangement that accentuates the intensity of the effort made to achieve it. Comparable transformations in internal structure, along with the subordination of the whole monument's volumetric and spatial composition to the movement along the main axis, are in evidence in structures of the madrasa type. In them the courtyard space is connected with the many secondary, uniform cells (*hujras*).

The dynamics that the formation of structure shows over time is similar to that of a complex genetic phenomenon, in which the building up of some spatial-compositional qualities of architectural organisms interact with the loss of others. Its evolution can be erratic, but it is spurred ever onward by man's attempt to master the architectural environment. To this stimulus of progress in spatial structures one ought to attribute the emphasis on compactness, the shortening of ways to reach focal points, the practice of regularly providing closed rooms with open and partially open connections to the outside, the integration of communicating spaces by extending structures along an axis or around a courtyard, and the concentration and

uncovering of the rooms grouped around them. This process can also be seen in dwellings.

The smoothest and steadiest internal structural transformations can be seen in the vertical lines of figure 1; these we will call architectural genotypes. They are distinct in that the nucleus of their cell has split up into other similar elements or has been transformed by extending its own niche-like offshoots, or by producing closed forms in the transitional space on the periphery of the nucleus. In every case for five or six centuries the cycle of transformations in the structure of architectural space proceeds along with the multiplication of focal points that results from the splitting off of subsidiary focal points from the main one. These changes are, as it were, predetermined in the organism of the architectural embryo, i.e., they are genetically programmed.

The combination of straight and erratic lines in the succession of structural formations from the seventh to the nineteenth century forms a fabric with a long and



3. Diagram showing development of interpenetrating structures.

irregular weave, produced by the asynchrony of the development and ultimate degeneration of genotypes. There are no dead ends in this history, however, for out of the remains of dead structures new symbiotic structures take shape through a process of simplification and the merging of neighboring branches.

The three basic genotypes represented by the middle group in the table (hypostyle mosques, Friday mosques, and madrasas) and the two genotypes of the next group (single-domed structures with niches, and large halls with chambers surrounding them) are inter-related, and their development leads to the creation in the eighteenth century of interpenetrating structures with broken up nuclear spaces and asymmetrical nuclear volumes (fig. 3). The future lies with these composite structures, because they carry within themselves the ability further to integrate volumetric and spatial forms. They resemble spatial clusters being constructed today on a branching, intercommunicating plan. These natural developments help to explain why interest in the structural models of the architecture of the Arab East has survived in so many regions.

The correlation between this structural-genetic determination of spatial structures unfolding over time and its functional implementation can easily be determined. Examples of monuments can be found that show an almost total congruence of functional and structural features (in musallas and Friday mosques, for example) that are contradicted only by the hypertrophied composition of analogues such as the mosque at Anau (fifteenth century) and the complex of Chor-Bakr near Bukhara (sixteenth century). As the number, variety, and interaction of focal points increased, the universality of spatial structures grew also. They lent themselves well to a variety of public uses—palaces, madrasas, caravanserais, khanqahs, and so forth.

Questions about the origins of the early mosques and of the Central Asian madrasas, which many scholars turn to when they begin to place the monument they are studying into the general chain of historical development, or when they enter into one of the incessant discussions about indigenous traditions and outside influences in the architecture of Central Asia, can also receive some answers from looking at the classification of public buildings by spatial structure. But other questions still remain. Where, for example, should we place the nine-domed mosques of the ninth-century Degaron mosque type or of the Turkish caravanserais with covered courtyards or the Azerbaijani buildings with a central dome surrounded by col-

umned galleries, and so on? These structures were not entered on the table partly because of the absence in the architecture of Central Asia of monuments that developed these forms, partly because some rare structures of obscure origin appear as parts of larger and historically complex structures. Mosques of the type represented by the Degaron and Chor-Sutun in Termez could have derived from the corner sections of mosques with columned courtyards, with an enlarged mihrab bay formed by columns (in Iran, the eighth-century Tarik Khana mosque at Damghan). Other more integrated and complete structures may also have been the prototype for the nine-domed mosques. Whatever the case, the table remains useful as the first attempt to classify the basic lines of spatial and structural formation and of its amplification and development.

A systematic approach to spatial form that brings out its structural-genetic features furnishes us with new information. In particular it demonstrates the regularities in the successive stages of development in the traditions of historical architectural culture.

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#### NOTES

1. An objective picture from the point of view of Marxist philosophy of the influence of the Muslim faith on the course of the material and spiritual culture of the peoples who profess it can be found in the works of such Soviet scholars as S. N. Grigorian, *Medieval Philosophy of the Peoples of the Near and Middle East* [in Russian], 1966, and V. K. Chaloian, *East and West: Continuity in the Philosophy of Ancient and Medieval Society* [in Russian], 1968.
2. The striking similarities in the regularity of biological and technological evolution are described in detail by S. Lem, who also notes "mistakes" in evolution and sees ways of overcoming them (S. Lem, *Summa technologica* [Moscow, 1968]). The ideas of N. Carver on the biological precedence of various cultures that allows them to spread beyond their borders (N. F. Carver, "Through Western Eyes," *Japan Architect*, 1964) have been developed by more recent scholarship, leading, for example, to the appearance of genetic aesthetics (G. N. Povarov, "Helicon Revisited, or the History of Culture in the Light of a General Systems Theory," in *Exact Methods in Investigations of Culture and Art*, a symposium held by the Scientific Council on Cybernetics of the Academy of Sciences of the USSR (Moscow, 1971).
3. The four periods of development of the Friday mosque advanced by Oleg Grabar do not invalidate the view of the evolution of the center in the structural layout of the city and

the gradually increasing complexity of its spatial nodes and connections that is outlined here (see Oleg Grabar "The Architecture of the Middle Eastern City from Past to Present: The Mosque," in *The Middle Eastern City: A Symposium on Ancient Islamic and Contemporary City Building in the Near East*, University of California at Los Angeles, October, 1966.

4. The illustrations referred to are from B. Denike, *Iranian Portraits* [in Russian], (Moscow, 1938).
5. The complex interaction of the proportions of interior and exterior architectural forms, of domes, and of the structures beneath and inside the domes (e.g., stalactites) subordinated to

the tectonics of single-domed construction, has been traced in several of my articles (I. I. Notkin, "The Development of the Structure of Single-domed Construction from the Fourteenth to the Beginning of the Fifteenth Century in the Shahi-Zinda Complex," *Architectural Heritage*, no. 13 (Moscow, 1961); idem, "Stalactites in the Shahi-Zinda Complex," in *Materials and Investigations on the History and Restoration of the Architectural Monuments of Uzbekistan*, no. 2 (Tashkent, 1968); idem, "The Architecture of Central Asia of the Thirteenth and Fourteenth Centuries," *General History of Architecture 3* (Moscow, 1969) [all in Russian].